

FOREST RESEARCH IN INDIA,

1937-38.

II.—PROVINCIAL REPORTS.



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FOREST RESEARCH IN INDIA, 1937-38.

PART II.—PROVINCIAL REPORTS.

CHAPTER I.

Silviculture.

A large number of sample plots was laid out by the F. R. I. party for teak and sandal in Coorg and for a number of species in the Andamans. The Coorg plots included replicated comparative thinning sets which should yield valuable results in time. Plots of the all-India co-operative bamboo management investigation in several provinces were remeasured and inspected by F. R. I. parties, and a number of improvements introduced.

Assam.—Natural regeneration of evergreen forests has been satisfactory in the Jaipur reserve where an experiment has been started for gradually lifting the canopy. In the Kamrup division, much progress has been made in establishing whippy regeneration of sal by controlled burning and rains weeding including pulling out of *Eupatorium*. Here, as well as in Kachugaon and Haltugaon divisions, systematic burning of sal forests is being done as a routine measure. Considerable progress has been made in the preparation of working plans and 10-year divisional plantation schemes.

Bengal.—In the *bhabar* sal forests experiments on successive annual burning have tended to lighten the undergrowth as well as to increase seedling recruitment of sal. Elsewhere, in moister sal areas, the policy of slow burning has been successful in killing out or reducing the luxuriant evergreen undergrowth; and it is hoped drier conditions favourable to sal regeneration will soon follow. The annual controlled burning in sal plantations for 9 successive years has changed evergreen undergrowth towards drier types.

In the Khasi valley evergreen forests, the divisional experiments have given indications that large gaps in natural regeneration caused by exploitation felling followed by mechanical extraction by tractor will have to be aided by artificial regeneration of fast growing plants.

Some amount of success has been obtained for the first time under the well-known "Kamrup method" for regenerating typical garjan (*Dipterocarpus* spp.) forests at Bhomoringhona, Cox's Bazar. The canopy was slightly opened by the removal of suppressed middle storey, the congested patches were thinned, undergrowth cut and burnt and the area was cleaned with the result that there was a profuse recruitment of healthy seedlings. Experiments to introduce *Dipterocarpus turbinatus* and *Eugenia grandis* under high shade by notching on a bigger divisional scale proved very successful and at a low cost.

In the case of *Nipa fruticans* (*golpatta*) in the Sunderbans, it was found that if an extra utilisable leaf were retained in each clump in addition to the unopened (or insufficiently opened) frond or fronds, there was an appreciable increase in the production of new shoots.

Bihar.—Observations on the effects of contour trenching on growth and water conservation have been continued, and the area trenched has been considerably extended. Successful reclamation work in heavily eroded soils has been effected by contour trenching followed by ploughing in seed of thatch grass or *boga* (*Tephrosia candida*) prior to the introduction of tree species. Controlled burning, as a regeneration measure, in dry sal forests is being given up in favour of complete fire protection.

Bombay.—As there was no special research officer, most of the local investigations were taken up by the territorial staff. An attempt at introducing *Cassia siamea* on the sites of deserted cultivation in the Thana catchment area (East Thana) was fairly successful. The 1935 experimental plots to ascertain the rate of growth of teak in plantation under different spacings (Dangs, Surat), measured up in 1938, indicate that an average spacing of 12'×12' is more advantageous in early years than that of 6'×6' or 9'×9' or 15'×15' in so far as girth increment is concerned, but the effect of the wider spacing on tree form and on establishment costs is not mentioned.

Central Provinces.—There is no difficulty in obtaining natural regeneration of sal in localities (Balaghat) where grass can be kept down by successful fire protection extending over several years and by light grazing and grass-cutting. Coppice regrowth is vigorous everywhere. Plantation costs have been reduced considerably and the cost of formation only of teak plantation amounted to Rs. 5 per acre. Successful agri-silvicultural work has been reported from some divisions (e.g., Yeotmal) and the method is being undertaken in localities where land-hunger is intense and cheap labour readily available.

Teak seeds kept in white-ant nests for a year after collection germinated readily when sown thickly in lines a few days before the monsoon set in. The *rab-cum-taungya* method is proving very successful in a number of places. The Forest Department is issuing propaganda leaflets

to make the public tree-minded and a small nursery is being maintained by the provincial silviculturist at Nagpur for raising suitable ornamental plants for sale.

Lantana has almost completely disappeared from fire-lines as a result of successive burning but not so elsewhere.

Coorg.—Experiments confirmed that sandal seed sown without pulp has given much higher germination than that with pulp. *Aleurites fordii* and *A. montana* germinated fairly well (the former better than the latter) at different nursery centres. These plantations in six localities are showing much promise. After a few years' experiments Coorg has also adopted premonsoon stump-planting of teak between the middle of April and the middle of May as standard practice.

Frill girdling and poisoning with sodium arsenite in evergreen forest regeneration areas killed more than 50 per cent. of the trees resulting in vigorous response by the seedlings underneath.

Madras.—Regeneration of dry fuel forests by the "rab" method and its combination with the raising of field crops (*rab-cum-kumri*) has been extended and improved. In many districts with the most unpromising soil and climatic conditions success with this kind of work is now a matter of routine. Great benefits obtained by soil working by forking in the early stages of the "rab" regeneration of dry fuel forests have been demonstrated further. Success has continued in the control of new outbreaks of the spike disease of sandal. Investigations into the best date of stump-planting and best size of stumps to use have been concluded for most of the important local species. In years of seed shortage, undersized teak stock in the nursery can be developed into good stock for the following year. The change in the technique of raising plantations by premonsoon stump-planting in crowbar holes and the improved weeding and tending methods have reduced the cost of formation of plantations by Rs. 10 to Rs. 15 per acre.

North-West Frontier Province.—The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*) and silver fir (*Abies pindrow*) specially in forests under the uniform system. Previous experiments to ascertain the most suitable intensity for a seeding felling in blue pine forests having given no definite results have now been given up and a new set of experimental plots laid out in their place to study factors affecting the progress of seedlings in recruitment and also to study the effect of grazing, of removal of *Viburnum* weed and of exclusion of rodents.

Sowing of *deodar* on burnt patches continues to give very good results in the blue pine regeneration areas in Upper Siran range.

In chir (*Pinus longifolia*) regeneration areas, where the young crop is established, the effect of increasing grazing incidence from 8 acres to 6 acres per head of cattle continues to be beneficial.

Orissa.—The main problem in Angul (old P. B. I. areas) is to find out how best to assist sal (*Shorea robusta*) regeneration against *Bambusa arundinacea*. Burning the clumps was not so effective as clearfelling. Experiments to raise teak stumps in dry *ab* nurseries proved successful in Angul, promising economy in nursery costs and reduced expense in carriage of plants to the planting site.

Rab sowings have successfully been made in several Divisions even on poor dry soil with various species. Sandal sowings under hushes with existing forest trees as hosts have given far better results than have clean weeding and sowing of host plants.

In Puri, *dona* (leaf eup) planting of teak gave very good results. Initial results from underplanting of *D. strictus* forest with teak stumps are promising.

Punjab.—Observations in high level *kail* (*Pinus excelsa*) forests as well as in mixed *kail* and *fir*, forests showed distinct improvement in natural regeneration where humus was scraped off or burnt.

As regards *Abies pindrow* and *Picea morinda* previous years' observations were confirmed, namely that the removal of humus and exposure of mineral soil gave significantly better results, and that the influx of regeneration was inversely proportional to the opening of canopy. Under strip fellings seedlings were more numerous in 50' and 75' strips as compared with wider strips, and under-sheltered reproduction was distinctly better in 20' × 30' gaps than in bigger openings.

Morus alba and *Acacia azedarach* underplanting in irrigated plantations of *Dalbergia sissoo* was very successful in Multan, Montgomery and Research divisions. *Cryptomeria japonica* and *Cupressus torulosa* did well in Kangra oak forests (Dharamsala) and *Prosopis juliflora* (Argentine form) did well in poor soil in irrigated plantation and together with arid and Mexican forms in dry foothill scrub areas. Agaves were found highly useful for erosion control. The erosion control work at Nurpur furnished a demonstration that after 3 years' closure the growth of grass had markedly improved and several indigenous plants made their appearance and are beginning to cover the ground. Clearfelling in winter followed by trenching in spring to get root suckers proved to be the best method for naturally regenerating *Dalbergia sissoo* high forest in riverain areas.

Planting espacement (*Dalbergia sissoo*) experiments at Chichawatni initiated in 1928 were closed. Results showed that closer espacements, i.e., 5' × 10' and 6' × 10', give higher outturn than 8' × 10' or 10' × 10' and are moreover better for controlling weed growth.

United Provinces.—The question of obtaining and establishing sal regeneration *de novo* continues to be the most important item in the programme.

Rains shrub-cutting is being successfully adopted in a fairly large scale in regeneration areas in the Haldwani, Ramnagar, Tarai and Bhabar Estates forest divisions.

Khair (*Acacia catechu*) trees, even large ones, produced coppice shoots if the roots were wounded below ground level after felling (Tarai and Bhabar Estates). In artificial regeneration khair cannot be successfully raised without rains weeding.

In S. Kheri and Pilibhit divisions the baib grass (*Pollinidium angustisolum*) plantations continue to be very successful on suitable areas,—some plots producing as much as 58 mds. per acre. Indications are that best results are obtained with a spacing of 2'×2'.

In underplanting experiments, *Eugenia jambolana* and *Holoptelia integrifolia* have developed well under dense khair (*Acacia catechu*) shade.

Botany.

The province of Assam continues to make contributions to the science of botany. Several new species were described and Volume II of the Flora of Assam was published during the past year. A very valuable collection of the woody and herbaceous flora of Assam, which is housed in Shillong, makes possible such additions to knowledge. One learns with considerable surprise that the staff which looks after this asset is still, and has been for many years, on a temporary basis.

The identification of the species of the evergreen forests has at last been taken in hand. The Forest Botanist paid a visit to South India during the last cold weather and dealt with about 7,000 trees in several parts of Madras.

The result of trenching the arid hills of Bamiajuru continues to attract attention. Far-reaching claims of success in changing the ground cover, in improving the growth of the trees and in altering the local climate have been made, but unfortunately no data of the untouched site are available for comparison. It is hoped that an ecological survey in the cold weather of 1938 will throw some light on the matter.

Utilisation.

In the sphere of Utilisation, there is much of interest to be read in the Provincial reports... .

Assam, Bengal, the Central Provinces, Madras, and the United Provinces all maintained a Forest Utilisation Officer either throughout the

year, or for part of the year. Bihar and the Punjab maintained Forest Research Officers who dealt with Utilisation problems as well as those of Silviculture and other branches of forestry.

On the whole, the provincial utilisation reports are very encouraging, and amply demonstrate how a Utilisation Officer can help in tackling specific problems and assist generally in improving trade in forest products and finding new markets where required.

Assam.—The Forest Utilisation Officer, as usual, showed great activity in trying to find markets for his province's timbers. He reports that a large seasoning kiln is to be erected by the Surma Valley Sawmills, which will greatly assist this firm to market their timbers in clean condition. He also reports that by using proper methods of air seasoning, the Assam Railway and Trading Company obtain 50 per cent. higher prices for air-seasoned timber than they do for green wood.

Several timbers were tried for pencil manufacture, but except for *Bischofia javanica*, which was reported as the "most suitable", none of the nine timbers tried were found suitable. *Bonsum* (*Phaebe goalparensis*) is said to be suitable for shuttles and is being used for this purpose in increasing quantities for handloom work. *Amoora wallichii* is reported on as being a favourite timber for furniture.

A match factory in Calcutta is taking *bhelu* (*Tetrameles nudiflora*), *pitali* (*Trewia nudiflora*) and *ladam* (*Anthocephalus cadamba*) for match work as substitutes for semul (*Bombax malabaricum*), supplies of which are inadequate to meet the demand.

As regards minor products, *Millettia pachycarpa* roots were tested for their rotenone content and were reported on as containing 2.8 per cent., a very encouraging result. The trade in canes was brisk, and prices rose by 15 to 50 per cent. The price of *Plumbago rosea* also increased to nearly double last year's figure, and the trade in several other products was brisk.

Finally the Utilisation Officer obtained a reduction in railway freight for many forest products, and it is anticipated that the new rates will benefit both the Forest Department and the Railway concerned.

Bengal.—The Forest Utilisation Office of Bengal is now in Calcutta, and the Forest Utilisation Officer reports that, judging by the increasing number of enquiries and requests for advice that he receives, the moving of the office from Darjeeling is more than justified.

It is emphasized that Calcutta is the largest individual market for timber in India, and that, although the potential provincial forest output is not fully sold, enormous quantities of timber are being imported into Calcutta. In the month of March 1938, no less than 8,000 tons of timber were imported into the town by sea alone. A very large

quantity of this is, of course, teak from Burma, but, nevertheless, there is scope for expansion of the Bengal trade in forest produce.

Numerous samples of timber were sent out by the Forest Utilisation Officer with the object of having the timbers tried for various purposes. Success was achieved in some instances. *Sonneratia apetala* was accepted for heavy packing cases, and *Bischofia javanica*, *Amoora wallichii*, *Cedrela microcarpa* and *Cedrela toona*, were accepted by a firm of pencil and pen manufacturers, for pencil making. The wood chiefly used by the same firm for cheap pencils is *Carapa obovata*, but supplies are limited and sizes are small. *Xanthoxylum budrunga* was tried for furniture making but proved very refractory.

Bihar.—Bihar reports that success was achieved in obtaining a reduction in railway freights on charcoal, and the Forest Research Officer was very active in the propaganda field. Pictorial post cards on forest subjects were widely distributed, and the Forest Department took part in exhibitions at Khunti, Ranchi and Calcutta. It is also reported that in Bihar propaganda and education of the general public and of engineers in forest and utilisation subjects is of paramount importance, and active steps are being taken to fill the want. One method proposed is the circulation of timber engineering magazines to the engineers of the province by the Forest Department. This is a sound policy which might well be followed by other Provinces. *Albizia procera* was tested by a Patna firm for gun stocks and was reported on as suitable if well seasoned and free of cracks. A small tool handle business was started in Chakradharpur, the main timber to be used being *dhaura* (*Anogeissus latifolia*). The woods being used by match factories are reported to be salai (*Boswellia serrata*), char (*Buchanania latifolia*), amra (*Spondias mangifera*) and semul (*Bombax malabaricum*).

A start has been made in supplying poles for electric transmission work, and orders for more poles have been received. A scheme for the electrification of the whole Province is under consideration. If it eventuates, at least 10,000 poles will be required. The question as to whether palmyra poles will be suitable for this scheme is being investigated. An Ascu treating plant was erected at Goilkera.

Central Provinces.—The Central Provinces also report an increased trade in electric transmission poles. Orders for poles of both teak and *Polyalthia cerasoides* were booked. The Allapilli sawmill cut 81,442 cubic feet of timber, and sold over 78,000 cubic feet for Rs. 1,32,012.

Over 95,000 sleepers were supplied under a 3-year contract to the Railways. A Bombay firm investigated a scheme for the utilisation of *Dendrocalamus strictus* bamboos for paper-making. If the scheme eventuates the mill will probably be erected either at Chanda or Ballarshah. A Delhi firm made enquiries as to the possibility of using salai

(*Boswellia serrata*) for plywood. *Gardenia latifolia* is being tried by the Linen Industry Research Association, Ireland, for spinning rollers.

In minor products, lac still holds pride of place, but the price for T. N. fell from Rs. 24 to Rs. 15-8-0 per maund. There was an improvement in the demand for *rusa* grass, and the leases fetched Rs. 5,319 as against Rs. 2,100 the previous year. The demand for *kulu* (*Sterculia urens*) gum also increased, but prices kept low. Over 75,000 cwt. of this gum were exported from Bombay alone during the year. An investigation to improve the tapping of *kulu* gum is under way. Other products showing increased trade include *kaitha*, *tendu* (*Diospyros melanoxylon*) leaves, and *harra* (myrabolams).

Madras.—Electric transmission poles were a subject of increased interest in this Presidency also, and schemes for the treatment of poles for hydro-electric work were submitted to Government. Both Ascu treatment and open tank treatment with creosote are under consideration. At the same time, the Kodaikanal Municipality are purchasing and erecting poles of *Pinus insignis* treated by the Osmose process. The results will be watched with interest. The question of the proper seasoning of sleepers has also been taken up. *Bohra* grass (*Cymbopogon coloratus*) was sent to Dehra Dun for pulp and paper tests. It was found suitable for cheap grades of paper if mixed with other long-fibred materials such as bamboo pulp. Samples of 6 timbers were sent to Dehra Dun for shuttle tests. *Evodia roxburghiana* was reported on by the Western India Match Co. as suitable for splints. *Ailanthus malabarica* is also reputed to be an excellent match wood, but supplies are scarce. Nineteen woods were tried by the Madras pencil factory for pencil work but none of them proved suitable.

Casuarina is to be tried for pole work. The Forest Department participated in provincial exhibitions at Salem, Calicut and Madras.

In minor products, *Nux-vomica* seeds showed a drop in price from Rs. 11-4-0 to Rs. 8-4-0 per candy. Imported wattle bark showed an increase over last year's prices, but *Cassia auriculata* bark prices declined. Experiments on the collection of this bark showed that one year old shoots had a tannin content of 16 to 20 per cent., while 2 and 3-year old shoots only increased in tannin content by 2 to 3 per cent. Enquiries for *kulu* (*Sterculia urens*) bark were received in this Province also.

North-West Frontier Province.—Sample logs of sissoo (*Dalbergia sissoo*) from the Lower Swat Canal banks were sent to the Forest Research Institute for testing for veneers. It was found to be highly decorative, and samples were shown at the Lahore Exhibition in December 1937.

Orissa.—The Mahanadi river in Barapahar division has been made possible for floating bamboos by blasting operations, and successful

floating operations have been undertaken. The Public Works Department have installed an Aseu treating plant at Koraput, and the local Government has issued orders that preference should be given to provincial timbers for all public works. Treated wood bridges are to be used on the Koraput-Rhayagada road. The terms of the bamboo lease for the Orient Paper Mills have been settled, and it is expected that the mill will start work in 1939.

Punjab.—With a view to educate the public on forest matters a forestry pavilion was opened in the All-India Exhibition of Arts and Industries held at Lahore in December 1937. Exhibits included erosion, forest working and Punjab forest type models and various forest products which could form the basis for the development of cottage or large scale industries. Over 3 lakhs of people visited the pavilion in the course of two months and many of them displayed a keen interest in the development of forest industries (Research).

United Provinces.—The post of Utilisation Officer was revived in October 1937, and Mr. D. Stewart, Deputy Conservator of Forests, was given charge of the Division. He made a complete survey of the utilisation work in the Province during the working season 1937-38, and his able report is worthy of perusal by officers in other Provinces, as it gives a very clear account as to how a Utilisation Officer can help his Department and stimulate trade in forest products on sound lines.

The seasoning of sleepers for the railways and the supply of both softwood and hardwood sleepers was one of the first problems tackled. The supply of poles for electrical transmission work was another, and the importance of keeping proper records of poles in service is emphasized. *Kulu* (*Sterculia urens*) gum was a profitable product in this province also, while the possibility of utilising chir (*Pinus longifolia*) and ulla (*Anthisteria gigantea*) for paper pulp was also explored. So far the results on these products look promising for the manufacture of cheap wrapping papers. The provincial output of semul (*Bombax malabaricum*) for the match industry was carefully examined, and the possibility of starting a plywood factory in the Province was also explored. Unfortunately supplies of possible timbers for plywood work in the United Provinces are at present insufficient to support a plywood mill. Steps are being taken to increase the provincial supplies of timbers suitable for matches, plywood, and the box trade. Such timbers are in deficit in most provinces in India and the question of plantations is one which should receive, if it is not already receiving, attention by all provincial forest administrators.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

ASSAM.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Staff.—The post of the Silviculturist continued to remain in abeyance throughout the year. Dr. N. L. Bor, Deputy Conservator of Forests, was in charge of the work, in addition to his duties as Botanical Officer, until the 10th October 1937, when Mr. R. N. De, Deputy Conservator of Forests, took over and held charge for the remaining period of the year. It has not yet been possible to get sanction for even the minimum office and field staff for the Silviculturist.

There were 18 silvicultural experimental plots (including three gardens) at the beginning of the year of which one experimental garden in the Sadiya division was made over to the territorial staff. Two new experimental plots were laid out, during the year, in the Lakhimpur division. Plantation schemes have been drawn up for most of the divisions.

(ii) Natural regeneration, etc.

As remarked last year, the natural regeneration of the evergreen forests is quite satisfactory in the Jaipur reserve where an experiment has been started of gradually lifting the canopy. Seedlings of *Dipterocarpus macrocarpus*, *Mesua ferrea*, *Shorea assamica*, *Manglietia insignis*, *Artocarpus chaplasha*, etc., are found almost everywhere under mother trees. In Cachar and Sylhet divisions, natural regeneration of *ping* (*Cynometra polyandra*), *kurtia* (*Palaquium polyanthum*) and *Dipterocarpus turbinatus* is very good in places.

In the Nowgong division two experimental plots have been laid out for natural regeneration of *sal* by rains weeding and by clearing bamboos and trees in places where good whippy regeneration of *sal* already exists. Both the plots are promising.

In the Kamrup division much progress has been made with establishing whippy regeneration of *sal* by controlled burning, rains weeding and pulling out *Eupatorium*.

In the Kamrup, Kachugaon and Haltugaon divisions systematic burning of *sal* forests, is being done as a matter of routine,

(iii) *Investigation of seeds.*

Experiments for germination test of various species were continued in the Lawacherra experimental garden (Sylhet), and the experimental plot No. 11 at Holongapar (Sibsagar) was also reconstituted last year for the same purpose.

Routine pre-treatment of seeds was done with several species and a few species were sown untreated. On the average good germination results were obtained from the former. In shaded beds, untreated *Amoora wallichii* seeds gave the quickest germination and upto 95 per cent. Some *Talauma phellocarpa* seeds were treated with Hydrochloric acid before treatment, but no germination was obtained. *Xylia dolabri-formis* seeds received from Burma gave very satisfactory results, with germination percentages of about 94 per cent. in shaded beds and 85 per cent. in unshaded beds. (It may be of interest to note that *Xylia dolabri-formis* trees in the Lawacherra plantation raised from Burma seeds in 1927 flowered in 1937. Some seeds were sown in a nursery bed and were found to be fertile. *Terminalia tomentosa* and *Hydnocarpus kurzii* planted in 1927 also bore seeds in 1937.)

(iv) *Investigation on Trees and Crops.*

(a) *Phenological data.*—Observations were continued on all trees selected for the purpose in different divisions in order to get reliable averages.

(b) *Inheritance of individual characters.*—Experiments were continued to determine hereditary characters in the distinct growth forms of *Lagerstræmia flos-reginæ*.

(v) *Nursery Work.*

Two experimental nurseries are being maintained at Lawacherra and Holongapar. In hot dry areas, shaded nursery beds gave generally a higher germinative capacity with nearly all species tried. *Bonsum* (*Phæbe goalparensis*) started germination in December and continued till April in the Holongapar nursery. *Alseodaphne ovalenii* seeds collected in the Caesar division did not keep well for more than 15 days after collection.

The experimental Cinchona plantation at Umsaw was maintained but it was decided not to extend this any more.

(vi) *Artificial regeneration.*

In nearly all divisions, plantations are being raised either departmentally or by *taungyas* and much useful information is being collected.

(vii) *Tending.*

Due to the introduction of plantation schemes, systematic tending of all plantations will now be ensured.

(viii) *Mixtures.*

Except in the *sal* forests, mixture of species is being introduced in almost all divisions and species suited to the locality has been prescribed in all plantation schemes.

(ix) *Underplanting.*

Underplanting of *gamari* (*Gmelina arborea*) by *cham* (*Artocarpus chaplasha*) in the 1929 plantation of the Raghunandan reserve was a great success and during the year under review a number of *gamari* trees were removed in thinning so as to admit more light to the *cham*.

In the 1935 *gamari*, *garjan* (*Dipterocarpus turbinatus*) underplanting in quineenox looks very promising and some of the *garjan* are as high as 8'.

(x) *Silvicultural systems.*

Working plans for the Kainrup and Goalpara forests are under revision and the shelter wood compartment system has been prescribed.

(xi) *Miscellaneous.*

(a) *Preservation Plots.*—These have now been selected in almost all divisions of the province and attempts are being made to systematize their records.

(b) *Cinchona plantation.*—The extension of the plantation at Umsaw in the Khasi and Jaintia hills has been stopped and the experimental plantations in the Garo and Mikir hills were also previously abandoned.

It has been found by analysis of the specimens of Cinchona sent that the alkaloid content is not inferior to that raised on a commercial scale in the Bengal plantations.

Mr. Wilson, Cinchona Expert of the Imperial Council of Agricultural Research, visited the Umsaw and the Mikir Hill plantations along with a Soil Chemist. It is understood that the growth of Cinchona plants is, according to Mr. Wilson, quite satisfactory at Umsaw and the soil is also suitable.

II.—WORKING PLANS AND STATISTICS.

(a) *Preparation and Control of Regular Working Plans.*

The working plan of the Nowgong and six reserved forests of the Sibsagar division has been brought into force in Nowgong with effect from the 1st August 1936.

The working plans for the Cachar and Sylhet divisions have been completed and sanctioned by Government.

Rapid progress has been made during the year in the revision of the working plans of the Kamrup and Haltugaon (Goalpara) divisions. They are both expected to be completed by the end of the year 1938.

A working scheme has also been prepared for the Nongkhylliem and adjacent Siem's forest in the Khasi and Jaintia hills.

Considerable progress has been made in the preparation of 10-year divisional plantation schemes.

(b) Preliminary Working Plan Reports.

The preliminary working plan reports for the revision of the Kamrup, Haltugaon (Goalpara) and Kachugaon (Goalpara) working plans were approved during the year.

III.—MISCELLANEOUS.

1. *Photos.*—11 photos of forest importance were supplied to the Central Silviculturist, Dehra Dun, for circulation. The Silviculturist took many photos of plantations and other items of interest during his tour.

2. *Weeds.*—Grazing as a factor in keeping down the weeds is fairly obvious in the *sal* forests of the Kamrup division where villages exist near all forests. Experiments have been started in the Nowgong and Darrang divisions to keep down weeds by controlled grazing. Some success seems to have been attained, but no conclusion can yet be drawn.

Loranthus which was playing havoc with the *gamari* (*Gmelina arborea*) plantations of the Sylhet division has been tackled this year by lopping the affected branches. The effect will be watched with a view to find out if the method is successful and cheap. *Sal, ajhar* (*Lagerstroemia-flos-regiae*) and other species are also attacked by this pest.

BENGAL.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Mr. J. C. Nath, Deputy Conservator of Forests, was in charge of the Silvicultural division, while the post of the Assistant Silviculturist was held by Mr. S. C. Chatterjee, Extra Assistant Conservator of Forests, throughout the year except for four months (July–November) when he was on leave, and Mr. S. K. Datta, Extra Assistant Conservator of Forests, was in charge.

(ii) *Natural regeneration.*

(i) *Sal*.—In the Buxa division, attempts to naturally regenerate areas in the *bhabar* tract were continued. The luxuriance of the under-growth has been considerably reduced and a slight increase of *sal* seedlings was noticed.

In the Raimatang *bhabar* also a fair number of seedlings in the unestablished stage are at present scattered all over the area, and the undergrowth is getting lighter by repeated annual burning, though the replacement of *Pollinia ciliata* by *Imperata arundinacea* is slow.

The experiments started last year, in order to study the applicability of the Kamrup method, in Kurseong, Buxa and Jalpaiguri divisions, were maintained. It was noticed at the end of the year that the recruitment of *sal* was more or less present in every type of forest. These experiments, however, have not been long enough in existence to yield definite results.

The policy of attempting to cold burn was continued in all *sal* areas that were similarly treated last year, with the result that much of the luxuriant evergreen undergrowth appears to have been killed out. It is hoped that repeated burning will result in drier conditions favourable to *sal* regeneration.

In the Darjeeling division the experimental plot at Ryang in the Tista Valley was maintained. The indicator plots are now fully stocked with seedlings in the unestablished stage.

In the Dacca-Mymensingh division, where natural regeneration is of secondary importance as coppice regeneration is quite satisfactory, a careful study of the growth of natural seedlings and their advance to the established stage, to replace casualties in coppice stools or to fill up blank areas, was continued.

(ii) *Other species*.—(a) Experiments started last year in Jalpaiguri division to study the effect of a burn of moderate intensity on the existing reproduction of *khair* (*Acacia catechuoides*) and *sissoo* (*Dalbergia sissoo*) in the savannah areas in riverain forests, and also to see if the treatment would induce fresh regeneration, were maintained. These have yielded no positive results yet. Early burning of similar areas in the Diana and Torsa forests was continued; it was not as a whole successful. There are different types of undergrowth, each of which requires to be burnt at a different time in the winter. The stock-mapping of these different types of grass undergrowth has been taken up and a sequence of burning will be decided on. The essential consideration is that the fire should not be so hot as to kill the regeneration beyond recovery or to damage the growing stock.

Experiments on similar lines started in Buxa division last year were also maintained in savannah areas and grassy blanks in high forest.

Early burning, combined with controlled grazing and broadcasting of seeds of miscellaneous species, has not yet produced any positive results.

(b) *Evergreen forests of Kassalong, Chittagong Hill Tracts*.—The experiments to determine a method of removing the existing overwood, which would ensure establishment of the advance growth of valuable species already on the ground, were maintained. Results of the last 8 years' work are very encouraging.

The large scale divisional experiment started last year was also maintained and another area of 50 acres was also taken up during the year for the purpose. The object of these divisional experiments is to find out whether, and at what stage, it will be possible to carry out concentrated fellings in such areas, as the success of departmental extraction depends on intensive fellings. The indications are pretty certain that the first stage of the work in both these plots will be based more or less on the principle that low shade is definitely harmful, and that large gaps in the canopy, caused by the exploitation fellings followed by mechanical extraction by tractor, where advance growth of the valuable species may be deficient or absent, will require such artificial aid as sowing or planting of seedlings of comparatively fast growth.

(c) *Dipterocarpus spp.*.—The experiments in Cox's Bazar and Chittagong divisions on the regeneration of *Dipterocarpus costatus* and *Dipterocarpus turbinatus* were continued in their typical forests, mainly *Dipterocarpus costatus* in the top canopy, a sparse middle storey of mixed evergreen species, and an undergrowth of coppice and shrubs—situated on flat tops of ridges at Bhomariaghona. A certain amount of success has been obtained, for the first time, this year, under the "Kamrup" method in typical *Dipterocarpus* forest at Bhomariaghona. The canopy was slightly opened by the removal of suppressed middle storey, and a thinning in the congested patches was carried out; the undergrowth was cut and burnt and the area was cleaned, with the result that profuse recruitment had appeared and the seedlings were quite healthy with an average height of 7" at the end of the year.

The experiments to introduce *Dipterocarpus turbinatus* and *Eugenia grandidis* under high shade by 'notching' on a divisional scale has proved very successful at a low cost as reported in last year's report. All these 'notching' experimental plots were continued to be maintained to study the effects of different methods and intensities of tending on the subsequent growth of *garjan* (*Dipterocarpus spp.*) plants.

Experiments on the 'notching' of *Dipterocarpus costatus* and *Dipterocarpus pilosus* were also continued, but with very little success.

Experiments on the tending of patches of pole crops of *garjan*, which occur sporadically throughout the Chittagong division, were continued. It appears that fire is harmful to the young *garjan*. The effect of

cutting back the miscellaneous species has not been very appreciable up to the end of the year.

(d) *Treatment of Nipa fruiticans*.—The experiments, started last year in the Sundarbans division, to study the effects of different methods of treatment of this palm on the production of leaf and seed, in different types of area, were continued. It appears that there is an appreciable increase in output, viz., up to 18 per cent., if an extra utilisable leaf is also retained on each clump, in addition to the unopened frond or fronds and the insufficiently opened frond which is unfit for use. Whereas the other treatments, viz., non-retention of any extra utilisable leaf per clump or cutting the utilisable portions only of the leaves, have shewn negative results,—the decrease being as much as 40 per cent. in one plot. These experiments have not been long enough in existence to differentiate the effects of different treatments on the production of seed.

(iii) *Nursery and Plantation Work.*

Nurseries were maintained at Takdah, Sukna, and Hazarikhil and a new nursery was opened at Khuntimari during the year.

Takdah (5,000' altitude, Darjeeling).—Seven species were sown during the year. Seedlings raised in previous years were planted out in the arboretum and divisional plantations. Of the exotics *Pinus khasya*, *Pinus thunbergii*, *Cupressus torulosa*, *Cupressus cashmeriana*, *Juniperus virginiana* and *Acacia dealbata* are showing the greatest promise.

Sukna (Kurseong).—Routine experiments were made on various indigenous and exotic species. *Sandal* (*Santalum album*) is showing promise of being successful in this climate—the maximum height of one year old plant being 3'-6". Of the exotics, *Cassia siamica*, *Aleurites fordii*, *Pterocarpus marsupium* and *Eucalyptus citriodora* and *Acacia lenticularis* continue to show rapid growth.

Hazarikhil (Chittagong).—Routine tests were carried out for numerous species. Among the exotics, *Xylia dolabiformis*, *Pterocarpus dalbergioides* and *Eucalyptus citriodora* continue to shew promise.

Stump planting.—Experiments with various species were continued in many divisions. In Darjeeling, stump planting in the spring and winter seasons has been undertaken with a view to find out the best season for planting.

Layering.—Owing to the difficulty of obtaining the seed, experiments with layering of coppice shoots of *Castanopsis hystrix* were initiated in Darjeeling, but so far without success.

“*Kharkhani*” areas.—Experimental sowings of *sul* in 1935 and 1936 on bumps in low-lying areas (*Kharkhani*) in Buxa, have progressed well

and similar bumps were again so treated in the current year's plantations.

Bamboos.—Experiments started last year to examine the possibility of introducing the exotic *Bambusa polymorpha* (of Burma) in the poor dry deciduous forests at Baraiyadhala, Chittagong, were continued.

The Gobania experiments, Chittagong, to find out the best rotation and the best method of treatment of *Melocanna bumbusoides* were maintained.

Plantations of exotics in the Darjeeling hills.—Experimental planting of exotics was continued during the year.

At Ramam (8,000' altitude), *Alnus incana* and *Larix leptolepis* are showing the greatest promise of success.

At Takdali (5,000' altitude), *Cupressus torulosa*, *Cupressus cushmeriana* and *Juniperus virginiana* are showing good growth.

Experiments to reduce the rate of growth of *Cryptomeria japonica* by close planting were continued both at Takdali and Bagora.

Plantation technique in the Darjeeling hills.—Line sowings of *Cedrela febrifuga* were successful in Tonglu (10,050' altitude), and the field nursery is the most economical method of raising plants of *buk* (*Quercus lamellosa*) and *phalant* (*Quercus lincuta*).

Experiments to aid artificial regeneration with coppice were started during the year at Sonada (6,487' altitude); it is however too early to report results. Similar experiments with wide espacement of the planted species and the preservation of coppice to fill in the intermediate gaps are being tried.

For protection from frost and exposure to strong winds, new working schemes were introduced during the year in Darjeeling division, prescribing clear-fellings in contour strips instead of by whole blocks and compartments. In some plantations cutting of fodder was stopped in order that the growth of weeds and coppice might protect the planted seedlings from exposure. It seems that continual fodder-cutting after *taungya* also causes further deterioration of the soil.

Mixtures in plantations.—The policy of intimate mixtures, rather than strips of 5 and 7 lines of each species, and standard espacements of 4'×4' for species of slower growth and 12'×12' or 16'×16' for very fast-growing *Burda* species are being followed in the Darjeeling hills. Elsewhere the mixture of species in alternate bands or strips of lines seems better. It will, however, take considerable time to obtain conclusive results from these experiments in mixtures.

Underplanting.—Experiments with (i) *Dipterocarpus turbinatus*, (ii) *Dipterocarpus pilosus*, (iii) *Hopea odorata*, (iv) *Swietenia macrophylla* under *Gmelina arborea*; and (v) *Dichopsis polyantha* under *Gmelina*

arborea and *Tectona grandis*, and (vi) *Artocarpus chaplasha* under *Tectona grandis* were continued. Of these (i) and (ii) are inexpensive and very successful; (iii) shows some promise of success; (iv) appears to be fairly successful; and (v) and (vi) also seem to be fairly successful in spite of their comparatively slow growth.

Thinnings.—Experiments in earlier thinning of *sal*, viz., in 3-to 4-year old instead of in 6-year old plantations, with a view to reduce the tendency to form epicormic branches, were maintained; it appears that the thinned *sal* lines are slower in their height growth, while crown development has not yet taken place.

Eradication of climbers.—The coppicing of *sal* in plantations, badly damaged by climbers, e.g., *gurja* (*Tinospora cordifolia*) and *kanchu* (*Mucuna pruriens*), mentioned in last year's report, has now been adopted in all *sal* divisions in Northern Bengal, particularly in bad cases of climber infestation in *sal*.

The experiment to study the effect of a burn of moderate intensity on the incidence of creepers, laid out last year in Dacca-Mymensingh division, was maintained.

Controlled burning in sal plantations.—Controlled (cold weather) burning in *sal* plantations of over 8 years old, was carried out in Kurssong, Kalimpong, Buxa and Jalpaiguri divisions for the 9th year in succession. It has been observed that the undergrowth in all the burnt areas has been gradually changing to a definite drier type and the incidence of troublesome climbers has become less and the general appearance of these plantations more healthy.

All the experimental plots to study the effects of controlled burning on the undergrowth, crop, soil conditions and incidence of climbers were maintained. Results to date indicate that the operation is beneficial.

The experimental plot in Dacca-Mymensingh, laid out last year to watch the effect of a burn of moderate intensity on the incidence of a defoliator in *sal*, was continued; the defoliator damage was less during the year but this cannot be taken as a direct result of burning as the experiment has not long been in existence.

(iv) *Miscellaneous*.

Loranthus.—The work on the removal of all *Loranthus* attacked *gamar* (*Gmelina arborea*) in plantations at Kaptai (including two sample plots), was undertaken during the year and considerable progress has been made. Similarly all *Loranthus* found in plantations of *toon* (*Cedrela toona*) at Madarihat were cut out and burnt before flowering with a view to minimise the spread of this parasite.

(v) *Preservation of Natural flora.*—A new plot was laid out during the year in savannah at Dantmara, Chittagong division. The total number of plots at the end of the year was 28.

Special investigation.—The Silviculturist undertook a special investigation on the possibility of augmenting the revenue from produce grown on the East Indian Railway land in Bengal and visited the area. He submitted his report, recommending experimental afforestation as a preliminary measure, to the Senior Conservator of Forests, Bengal, at the conclusion of his tour.

II.—WORKING PLANS AND STATISTICS.

(i) The revision of the Working Plan for the forests of Darjeeling division has been taken up.

(ii) The revised Working Plans for the forests of Chittagong and Cox's Bazar were under compilation during the year.

(iii) The Working Plan for the forests of Dacca-Mymensingh division was completed during the year and sent to the Press.

(iv) *Miscellaneous*—

1. Records of all measurements of scientific plots requiring computation were sent to the Central Silviculturist, Dehra Dun. There were 386 scientific plots at the end of the year and routine measurements and observations were done as usual.
2. *Measurement of Heartwood and Sapwood.*—Statements supplied by the Divisional Forest Officers will be tabulated and published as a bulletin.
3. *Ring countings and stem analyses.*—Silvicultural Bulletin No. 2 (part I), showing the Volume/Age curves of the more important species of the province, as reported last year, was still in the press at the close of the year. Further work on the stem analyses of important species was continued during the year.
4. A classified list, according to species and locality, of all the scientific plots maintained by the Silvicultural division, was prepared and sent to the press for publication as Bulletin No. 3;
5. The quinquennial research programme for the period 1938-43 was published after the close of the year.
6. *Records.*—The Specific and General Ledger files now number 230 and 173 respectively; and there are 646 photographs in the collection.

BIHAR.

1.—EXPERIMENTAL SILVICULTURE.

(i) General.

Early Burning.—Research in this Province has proved that “early burning” is not necessary for regenerating the *sal* forests except perhaps in the extremely moist types which are comparatively small in extent. In other places it does more harm than good, causing retrogression to a drier, more unhealthy type. Water instead of fire is now being experimented with.

Erosion.—A study of erosion run-off experiments by the Research Officer, in the Punjab, showed the value of long grass in checking run-off and soil losses. A tour through Kolhan division, during September 1937, revealed that outside the irrigated area of Bamiaburu, many of the hill slopes possess insufficient cover of trees, grass or undergrowth to check run-off completely.

Contour trenching.—Research into the effect of contour trenching on forest growth, soil moisture, and climate is proceeding systematically. Advice on climatic data to be collected, has several times been given by the Meteorologist, Alipore, Calcutta, to whom grateful thanks are due.

Climatic data of several stations surrounding Bamiaburu, are being regularly recorded as well as at Bamiaburu itself. Both temperature and rainfall figures are suggestive that contour trenching may be having a humidifying and moderating effect on the local climate, but it will not be possible to draw definite conclusions from such data for a number of years,—*i.e.* until sufficient figures have been collected to enable average figures to be obtained which will show significant differences irrespective of chance annual fluctuations. The fact that the number of rainy days at Bamiaburu is greater than those of other local stations with higher rainfall is also suggestive. It is further claimed that an improvement in site quality in the *sal* forests treated with contour trenching has resulted, but here again, owing to the impossibility of getting proper controls for comparison, it is not yet possible to substantiate these claims statistically.

There is no evidence to show that the intensity of the rain is increased. On the contrary the evidence at Bamiaburu shows that many of the rains are very light, or drizzles. No extra flooding of local rivers need, therefore, be apprehended,—in fact, irrigated forests will be more effective in holding up the run-off.

“Blank” areas [Experimental Plots 22(a), (b) and (c)] in four years show a noticeable progression towards the establishment of a *sal* pole

crop. It is estimated that the crop will be fully established ten feet high in less than ten years from now.

The cost of contour trenching incidentally works out at about Rs. 160 per mile or about Rs. 6 per acre with the trenches 70 yards apart. A new scheme was started in the Roro area, 10 miles of trenches being dug. The completed scheme, which joins up with and includes Bamiaburu, will comprise one hundred miles of trenches in an area about fifteen miles long by three to four miles wide in places.

(ii) *Natural Regeneration.*

In the dry types of *sal* forest in Bihar, it is found that burning tends to create a still drier type less favourable for regeneration. Burning as a regeneration measure is therefore being given up. The area of moist *sal* forest where fire might be of advantage in creating conditions favourable for *sal* regeneration is relatively small.

(iii) *Seed.*

Pinus caribaea seed received from the Forest Research Institute germinated well, and has done fairly well in spite of being reported as specially tender in its early stages.

(iv) *Nursery Work.*

Research in the Hinoo Nursery is being conducted into the merits of xerophytic species, mainly of the Punjab origin, for reafforesting dry blank areas. Research into the characteristics of boxwood and plank-ing wood species of other provinces continues.

Considerable economies in the cost of farmyard manure are being made by breaking down organic waste by the Indore method.

(v) *Artificial Regeneration.*

Plantations.—Costs in the Leda 13 plantation have been reduced to Rs. 10 per acre including nursery costs. Plants are now put out with the aid of string knotted at 6' intervals instead of the former costly staking method. Forty-seven acres of miscellaneous forest was clear-felled and planted up in this area, and 28 acres in blank areas of Leda 8, and 4 acres in Gommore protected forest. *Teak* was mainly used. *Toon* is reported to be doing well.

In Kurchulta, entire transplants of *Robinia pseudo-acacia* planted out in August failed to become established.

Sabai grass (*Pollinidium angustifolium*) plantation.—After yields had fallen steadily for a number of years, these rose in 1936 and 1937. The increase is attributed to the heavier rainfalls of those two years.

Manuring experiments with artificial manures, against a fire protected and fire burned plot, are inconclusive. All yields have risen due to heavier rainfall. The artificial manure is costly to purchase and it is doubtful whether even if an increased yield resulted it would compensate for the extra cost involved.

(vi) *Reclamation and Afforestation.*

Reclamation of heavily eroded soils.—Some success was obtained at Bichaburu (Chaibassa division) in reclaiming heavily eroded erumbly chromite soils and erosible clay soils by first digging contour trenches about 50 yards apart and then ploughing in sowings of thatch grass or *boga* (*Tephrosia candida*). Ploughing along the contours was found to be preferable to ploughing up and down the slopes. Tree planting done at the same time, using *Gmelina arborea*, *teak*, *Pterocarpus marsupium*, *Cassia siamea* and *Azadirachta indica*, was only partially successful in spite of the contour trenching. It is now considered advisable to fix the soil first by means of grass and *boga* before tree planting is undertaken.

Reafforestation of blank areas in protected forests.—The use of *boga* (*Tephrosia candida*) as a nurse crop and soil improver has been found beneficial in reafforestation of blank areas in localities which suffer from drought. Sowings of *boga* are ploughed in at the commencement of the rains—the ploughing being done along the contours. The *boga* lines were 2 feet apart with tree species planted in every third line. It is believed that alternate lines of *boga* and tree species 3 feet apart may be preferable.

There are indications that contour trenching may be of value in reafforesting dry blank areas. It appears to increase the soil moisture content helping the plants to carry through the succeeding hot weather.

(x) *Silvicultural Systems.*

Bamboo rotation experiment.—Experimental plots have been laid out in the Hinoo nursery, Ranchi, on rotations of 4, 5 and 6 years to discover which rotation is the best for working selected bamboo forests in the interests of the *Turis*,—bamboo basket-makers. Two felling cycles are arranged within each rotation, one for the basket-maker exploiting the immature culms and the other for the regular trader. Two series of plots are being provided, the one for basket making to exploit culms one year old, and the other culms of under one year. $2N+6$ culms are to be left in each clump by trader, N being the number of new culms which appear in the clump each year. The plots will be repeated in forest divisions next year.

(xi) *Miscellaneous.*

Soil Moisture Tests.—Soil moisture tests taken at the hottest time of the year, when no rain had fallen for six weeks on contour trenched and untrenched land in the Nankum Lae Orchard near Ranchi, showed the contour trenched area, which in the previous monsoon had held up the run-off, to have greater moisture contents at the 1' and 3' deep levels. Such an increase would probably react favourably on the lac crop.

Oecological observations.—Spear grass (*Heteropogon contortus*) appears to be dying out at Bamiaburu and giving place to Sabai (*Polliniidium angustifolium*). *Strobilanthes auriculatus* is spreading.

The *sal* forest, contrary to expressed opinion, is not changing to mixed forest under irrigated influence. Dry peninsular *sal* forest appears to be changing to moist peninsular *sal*, and dry mixed forest to moist mixed in contour trenched areas.

Fungal diseases.—The incidence of fungal attack, by *Polyporus shorea*, *Fomes tricolor* and *Trametes inscra* seems to be greatest on dry soils and least on lateritic soils indicative of high rainfall. This will be verified by further observations.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

Khurchutta Forests.—Schemes have been included in the revised plan for contour trenching the whole of the "Old Reserves", and selected blocks of the new, in addition to "eroded" areas which are being planted up, in order to prevent the retained standards in the coppice forest from going top dry, owing to uncovering the forest floor in fellings, and to improve growth in a neighbourhood, where wood is scarce. Experience suggests that we should endeavour to improve the forest growth to its utmost capacity in such places in order to help to relieve the wood famine which prevails.

Kodarma Plan.—Khair working circles are to be introduced, and a Miscellaneous Working Circle with *salai* (*Boswellia serrata*) as the chief wood for export. Arrangements are being made in all plans for the introduction of rotational grazing where this is feasible.

III.—MISCELLANEOUS.

(i) *Photography.*

88 photographs were taken by the writer during the year, 6 photographs were taken by the Conservator of Forests on irrigation, 4

were taken by the Divisional Forest Officer, Palamau, and 2 by the Silvicultural Ranger.

23 slides were also made from these photos to augment our subject material for lantern lectures. We have now a collection of 218 slides.

(ii) *Weeds.*

The Divisional Forest Officer, Saranda, is firmly convinced of the efficacy of cutting climbers during the rains in conversion working circles. After two years of persistent cutting few are left on the area.

BOMBAY.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

There were only six subjects under investigation under the control of the Chief Conservator's office, while some subjects of local interest were taken up for investigation by the territorial Divisional Forest Officers.

(ii) *Natural Regeneration.*

Evergreen forest.

The three plots laid out last year in the sub-tropical evergreen forest at Bhimashankar in the Poona division, with the object of studying the effect on regeneration of (1) removal of undergrowth only and (2) removal of undergrowth and opening of the canopy, were maintained, but it is too early yet to record any results.

(iii) *Artificial Regeneration.*

*Hirda (*Terminalia chebula*).*

Subject No. 37.—Sowing and planting of *hirda* on laterite soil in the shade of existing shrubs or small trees (Poona and Satara divisions).

Two new plots were selected in the Budhele catchment area in the Poona division. In plot I, *hirda* seed was sown in 100 pits, 3 seeds in each pit, and the sowing had to be repeated as the seed originally sown was eaten by white ants. In plot II, 100 transplants were put out. Weedings were carried out in July and September. Survivals to the end of January 1938 were 15 seedlings in plot No. I and 60 transplants in No. II.

In the Mahableshwar range (Satara division), *hirda* seed was sown in 100 pits,—2 seeds in each pit,—during the rains of 1937. 28 seeds germinated out of which 21 were surviving in March 1938, the average height of the seedlings being 2 inches.

Cassia siamea.

Last year's attempt at introducing *Cassia siamea* on the sites of deserted cultivation in the Tansa catchment area in the East Thana division, was fairly successful. The plants have grown to an average height of about 6 feet and the grass is almost suppressed. Only one weeding was required to be done in the 2nd year as a precaution against fire damage.

*Tung (*Aleurites fordii*).*

All the three surviving plants in the teak-pole coupe in Sambrani range and at Tatwal died during the year, probably due to excessive drought.

A nursery was made at Bomanhalli for further experiment of this species, the seed being sown 12" apart in raised unmanured beds. The sown seed was watered twice in the day both in the morning and evening. Out of 396 seeds sown, 77 germinated to the end of March,—germination having commenced from the 26th of February and continued till the end of October, by which time, 37 more seeds germinated bringing the total to 114.

The growth of these plants was very fast, and they were getting congested in their original beds. Accordingly 63 plants were carefully transplanted, 3' apart, in an extension of the present nursery on the 29th to 30th September 1937. In the original beds too, an endeavour was made to leave the existing plants spaced 3 feet apart, watering being continued for the 63 transplants only to assist them to establish themselves but they were not manured.

Out of the total of 114 that had germinated, 13 plants died between November and March without any ascribable reason. The surviving 101 are doing well, and height of the tallest plant is 71" while the average is 51".

Chlorophora excelsa (Uganda).

A quarter lb. of seed of *Chlorophora excelsa* (Uganda), received for trial from the Sivliculturist, Dehra Dun, in August 1937, was tried in East Thana, East Nasik, West Nasik, North, East and West Khandesh and Kanara Northern and Eastern divisions, but was not successful.

except in Kanara N. D. where it was tested in four different localities, with the following results :—

Particulars.	LOCALITIES.			
	Kulgi.	Virnoli.	Sambrani.	Haliyal.
Date of sowing . . .	16-8-37 and 30-8-37	10-9-37	28-8-37	31-8-37
No. of seeds sown . . .	500	548	1000	800
Date of germination . . .	24-9-37	25-10-37	9-9-37	25-9-37
No. germinated . . .	40	41	882	242
Germination percentages	8%	7%	40%	30%
Maximum height . . .	6"	3"	0"	7"
Condition of plants . . .	Healthy.	Fair.	Very healthy.	Healthy.

Seeds were sown in baskets and planted out in nursery beds when of suitable size ; transplanting will be done early in June.

(iv) *Tending—Thinnings and cleanings.*

*Teak (*Tectona grandis*).*

Subject No. 34.—Effect of different degrees of thinnings in teak plantations (Kanara N. D., E. D., and W. D.).

The next remeasurement is due in 1940-41.

Subject No. 34-A.—To determine the intensity of thinning most suitable for pure teak rabs at intervals laid down in the revised Thana working plan (West Thana division), i.e., at the 11th, 26th, 46th and 66th years.

Four plots (A, B, C and D) have been laid out in the West Thana division where the following treatments have been applied :—

Plot A—Unthinned (control).

Plot B—Thinned to "B" grade.

Plot C—Thinned to "C" grade.

Plot D—Thinned to "D" grade.

The thinnings were carried out in December 1937 after the initial measurements had been recorded. Remeasurements are to be taken every fifth year.

Subject No. 34-B.—To ascertain rate of growth of teak in plantations under different spacings (Dangs, Surat).

Two sets of 8 plots each, one in North Dangs and the other in South Dangs, are under observation for studying the rate of growth in teak plantations thinned to different espacements. The plantations when the plots were formed (in 1935) were 7 years old. The plots were thinned in January 1936 as below :—

Plots 1 and 5—6'×6' (control).

Plots 2 and 6—9'×9'.

Plots 3 and 7—12'×12'.

Plots 4 and 8—15'×15'.

The first remeasurement in these plots was taken in January 1938 and the results are given below :—

Average annual increment per tree.

Plots.	1 and 5.	2 and 6.	3 and 7.	4 and 8.
North Dangs (Dagdiamba)	. .	.68"	.70"	1.37"
South Dangs (Waghnai)	. .	.52"	.78"	1.29"

The percentage of girth increment for the several plots is as follows :—

Per cent.

Plots 1 and 5—21.72.

Plots 2 and 6—28.72.

Plots 3 and 7—39.97.

Plots 4 and 8—22.90.

The above figures indicate that an average spacing of 12'×12' is more advantageous than that of 6'×6' or 9'×9' or 15'×15', in early years so far as girth increment is concerned.

Plots Nos. 11, 12 and 13, Narayanpur Block, Navapur Range, West Khandesh Division.

These plots were laid out in April 1928 and remeasured in March 1933 and May 1938. Plot No. 11 was kept untouched, plot No. 12 was given an improvement felling at the time of formation, and plot No. 13 was clearfelled and patches of teak plantation were made during the succeeding monsoon.

During the 10 years the plots have been kept under observation, 33 teak have come up into the 6"-12" class in plot No. 11,—29 prior to 1933 and 4 between 1933 and 1938. In plot No. 12 only 11 teak came up into this class in the first 5 years to 1933 while none came up into the class between 1933 to 1938. It therefore seems that the improvement felling in plot No. 12 fulfilled its function in so far as it concentrated increment upon the larger stems without dissipating soil fertility in producing regeneration. The number of teak removed in the improvement felling in 1928 from this plot was 86. How far a heavier felling would have succeeded in putting on greater increment in the larger girth classes cannot be known nor how serious is the suppression which has evidently occurred in the smaller girth classes. Plot No. 13 has been left untouched since its plantation patches were formed and has suffered severely from frost, probably due to the unhealthy condition of the plants in consequence of their congested state. Drastic treatment is necessary here.

Acacia arabica.

Plots Nos. 1 and 2 at Pimpalgaon in Dhond Range, Poona Division.

These $\frac{1}{4}$ -acre plots were laid out in 1927-28 and the trees were remeasured in 1931-32 and 1937-38. The crops in both plots were 21 years old at the time the plots were laid out and had received no interim treatment except that dead and fallen trees had been removed from time to time. Plot No. 1 was kept untouched as a control for plot No. 2, which was thinned by removal of 24 trees, i.e., 45 per cent. of the crop. The average girth at breast height of the former was 21.4 inches, while the average girth of the latter was 23.8 inches. After 10 years 13 trees have died or been removed from plot No. 1, leaving 52 trees with average girth of 28.5 inches, while the 27 trees remaining in plot No. 2 average 32.06 inches. Both plots will be felled during the year 1938-39 and the total outturn from each in branchwood and stemwood will be accurately measured.

Plots Nos. 3 and 4 at Pimpalgaon in Dhond Range, Poona Division.

These plots were laid out in February 1929 and remeasured in November 1931 and December 1937. They are similar to plots Nos. 1 and 2 except that the crops were only 15 years old when the plots were formed and that the two plots were not initially truly comparable.

Plot No. 7 at Kangaon, Dhond Range, Poona Division.

This plot ($\frac{1}{4}$ -acre) was formed in March 1929 when the crop was 5 years old. The object of the plot was originally to ascertain whether

babul (Acacia arabica) of a suitable size for fuel could be produced in a shorter period than 40 years. The plot was "mechanically" thinned at the time of formation leaving 185 trees in the plot. In 1930 the object was altered as the original object had already been answered in the affirmative by study of similar adjoining crops. Accordingly, the plot was divided into 2 halves, the one being left as thinned already and the other thinned much more heavily to a spacing approximately equal to the crop height. Measurements were taken again in 1933 and a little further thinning done in both halves of the plots. In December 1937 measurements were again taken and a much more drastic thinning carried out, still keeping the first half much denser, than the second, retaining 43 and 25 trees respectively.

Miscellaneous species.

Subject No. 16.—Effect of improvement fellings on diameter growth (Dangs, Sural).

The plots were maintained and their next measurements are due in December 1939.

Evergreen forest.

Plot No. 24—Bombay sub-tropical evergreen forest, Mahableshwar (Satara).

This is a 2-acres plot (formed in January 1933) divided into 4 sub-plots. One was kept untouched as a control and the remaining three sub-plots were given selection fellings of varying intensity to study the results in yield and regeneration over a period of years. The first quinquennial measurements taken in January 1938, give some interesting results, for regeneration in sub-plot 1 has been much less satisfactory than in sub-plots 2 and 3 under much heavier felling.

(v) *Miscellaneous.*

*Sandal (*Santalum album*).*

Subject No. 7.—Annual girth increment of sandal (Belgaum and Dharwar-Bijapur divisions).

The triennial measurement of girth in plots 7AI to 7AIV was carried out in May 1937.

The average girth increment per tree per annum for the whole plot from the date of formation up to the last date of measurement is given in the following statement :—

Plot No.	Girth increment in inches per tree per annum.			
	1928.	1931.	1934.	1937.
7AI . . . . . . .	.20	.11	.14	.09
7AII . . . . . . .	.18	.13	.11	.07
7AIII . . . . . . .	.23	.22	.10	.09
7AIV . . . . . . .	.10	.13	.10	.07

(N.B.—Only those trees registering an increase in girth have been taken into account in arriving at the increment figures.)

Subject No. 32.—Correlation existing between the outer girth increment and heartwood increment of sandal (Dharwar-Bijapur division).

The next measurements and borings are due in 1938-39.

Evergreen forest (Bombay sub-tropical evergreen).

Plot No. 20—Mahableshwar (Satara).

The plot was originally formed in 1932 in quality I forest to study the effect of coppicing at different height from ground level. This investigation has been completed. The plot provides an interesting contrast to the surrounding area which was worked under the old plan at the same time as this was made a "type" felling for the new plan, the felling for the old plan being much more drastic.

Plots Nos. 21, 22 and 23 (1-acre each), Mahableshwar (Satara), formed about the same time are parallel plots to No. 20 but in Quality II, III and IV types of forest. Their second measurements were taken in January 1938.

Sheep grazing.

Plots Nos. 28 and 29—Bhamburda, Poona Division (South Indian Dry mixed deciduous forest).

Two 1-acre plots were formed in September 1936 to study the effect of sheep grazing in open forests of this type. After enumeration of all stock of tree species the area was handed over to the Agricultural Department for their sheep breeding experiments.

Phenological observations on teak.

These were continued during the year on sets of 5 trees in each of the Panch-Mahals, North Thana, North, East and West Khandesh and Kanara Northern divisions, and copies of records sent to the Central Silviculturist.

Enterolobium timbocua Mart.

Last year's survival at Mahableshwar is flourishing and has attained a height of 2'-8".

Fire protection.

In order to reduce the fire hazard in clear felled coupes where grass grows in profusion, the Divisional Forest Officer, East Thana, got a 5 feet ring cleared round promising groups of teak coppice in one and two year old coupes. The result is stated to be very satisfactory as the teak coppice shoots have not suffered any appreciable damage from fire and are growing vigorously.

II.—WORKING PLANS.

The following working plans were sanctioned during the year :—

1. Revised working plan for the Nasik Above-ghat Forests.
2. Working plan for the Castle Rock Fuel Supply, Kanara N. D.
3. Revised working plan for Yellapur-Mundgod Teak High Forests, Kanara, E. D.

CENTRAL PROVINCES AND BERAR.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

As experience is gained, it is becoming more and more evident that variations in the quality and composition of the Central Provinces forests and in the climatic and economic conditions are so great and change with such frequency that the standard systems of management, adopted so far, have failed to give the most satisfactory results.

Thus, for the Betul teak forests, prescriptions have been evolved which aim at treating each type of forest according to its special requirements and peculiar local conditions. In the more or less level plateaux on the hill-tops carrying an open, bamboo-less teak forest with much grass, it is considered advisable to retain the best poles at the time of

final fellings. On the hill slopes carrying a scattered overwood of mature or over-mature trees, with a dense underwood of bamboos suppressing abundant teak reproduction, all growth including advance reproduction and bamboos is being clear-felled, to allow the teak coppice to grow vigorously and thus overtop the bamboo regrowth. The open teak forests of the plains which are devoid of bamboos, contain scanty reproduction, and are liable to damage from frost, are worked under conservative improvement fellings under which only mature and over-mature trees are to be removed and congested woods are to be thinned out.

The following general observations in experimental plots and forests are of interest :—

In Balaghat, species such as *Terminalia tomentosa*, *Eugenia jambolana*, *Terminalia chebula*, etc., which are believed to minimize frost damage are being encouraged in opened up *sal* forests in frost-labile localities. In Nimar, frost continues to be the most important factor threatening regeneration. In Raipur, it is generally recognised that rainfall is just sufficient to support the growth of *sal* in its extreme western limit. Conservation of all the available soil-moisture, by avoiding undue gaps in the leaf canopy is considered desirable. Clear-fellings in such forests have therefore been replaced by a gradual removal of the overwood, and the results obtained so far have been gratifying.

(ii) Natural regeneration including coppice and root suckers.

North Chanda.—The object of E. P. 3 (1926) is to see if reproduction of teak can be induced in a thinned teak high forest infested with bamboos by (A) annual cutting (December) and burning (April) of bamboos; or by (B) fire protection. The only conclusion that can be drawn from enumeration of stocked squares, assuming that the sub-plots were initially comparable, of which there is no evidence, is that some seedling reproduction has been induced as a result of both the treatments. Between the two treatments, however, there is no marked difference.

Betul.—The object of E. P. 12 (1931 and 1937) is to find out the best method of obtaining natural regeneration of teak in a bamboo-less teak forest. Five sub-plots were formed in 1931 and treated as under :—

- A. No grazing, annual burning.
- B. Grazed, annually burnt.
- C. No grazing, contour trenched at 6' interval
- D. Grazed, trenched as C.

— — —

No reliable data regarding initial comparability or progress of regeneration since 1931 were maintained. Observation in 1937 showed that reproduction had not come up to any appreciable extent in any of the plots, and this paucity of regeneration appeared to be chiefly due to a dense overwood, which was, therefore, thinned out.

The following observations are reported from divisions :—

Balaghat.—There is no difficulty in obtaining natural regeneration of *sal* in localities where grass can be kept down by successful fire protection extending over several years, and by light grazing or grass cutting. Coppice regrowth is vigorous everywhere but in some places it is liable to attacks by gall insects which tend to prevent straight growth.

Bhandara.—It is noticed that in the mixed forests, fellings done towards the end of the hot weather are harmful as many stumps are killed due to the separation of the living bark from the wood.

Bilaspur.—Seeding of teak was unsatisfactory in North Raipur. Coppice regeneration of the important species was satisfactory in the worked coupes, but damage due to browsing by wild animals and to some extent by frost and accidental fires was noticed in some places.

Mandla.—To induce natural regeneration of *sal* in the Banjar forest local experiments were laid out as under :—

- (i) Two plots, one acre each, were selected. The overwood was heavily thinned out. One plot was fenced and the other left unfenced. Both were weeded in July and November. The resulting regeneration in both is excellent but the shoots in the unfenced plot have been badly eaten by *chital*. It is generally the large shoots, that are damaged ; the small whippy ones are left practically untouched.
- (ii) In compartment 637, a plot of $2\frac{1}{2}$ acres with *sal* coppice shoots was fenced (cost Rs. 80) and weeded, with the result that the shoots are coming straight up. The neighbourhood of this plot has also been weeded with very good results, but some of the shoots have been damaged by deer.
- (iii) An area of two acres was clear felled, burnt and planted up with *sal* seedlings and fenced. The clear-felling and burning have proved a complete failure, all the seedlings having died back. (The cost was Rs. 38.)
- (iv) In 1936, five acres were clear felled and fenced. Frost has killed back the seedlings two years running, inspite of the fact that damaged shoots were cut back each year. This and the previous experiments go to show that clear felling must be abandoned once and for all.

Nagpur-Wardha.—Trials made to induce root-suckers from *Terminalia tomentosa* by digging 1' deep circular trenches round the trees and 7' away from the trunk proved a complete failure.

Nimar.—*Hardwickia binata* regenerates well both from seed and coppice but is grazed with avidity. *Anogeissus latifolia* is similarly damaged, but whereas the former is hardy enough to withstand grazing the latter is being gradually eliminated.

North Chanda.—Regeneration of *Pterocarpus marsupium* is very scanty even in areas with a large proportion of mature trees. The coppice regrowth of teak however is very rapid (40' high, and 20" in girth in 10 years), especially from small-sized stumps.

Raipur.—Clearfelled areas in the sal working circle have been well-stocked with coppice shoots but the bulk of these though superficially well-shaped are unsound due to frost attack and will not produce boles which could be cut into sleepers. These will however admirably serve the purpose of a shelterwood which will enable the natural regeneration that is struggling underneath to develop without getting frosted.

Sauror.—Coppice regrowth of *Anogeissus pendula* in the Ramna reserve is not very promising.

(iii) Seeds.

Seed supply.—The year under report was one of the poorest teak seed years on record and considerable difficulty was experienced in meeting the demand.

Seed pre-treatment.—To hasten germination of some of the obdurate species like *Poinciana regia*, certain *Cassias*, *Guaiacum officinale*, etc., the seeds were treated with concentrated sulphuric acid for 5 and 10 minutes, with good results.

(iv) Nursery Work.

Silviculturist's Experimental Forest.—A small forest, in which is situated the 1 acre Ornamental Tree Nursery, has recently been placed at the disposal of the Silviculturist for experimental work. The following experiments have been started therein :—

(i) Heredity trials with solid *Dendrocalamus strictus* to see—

- (1) If seed from such culms produce solid culms.
- (2) If rhizomes from clumps with most of the culms solid, produce solid culms.

(ii) To find out if *Chlorophora excelsa* can be successfully grown in the forests of this province.

Some seed from Uganda, received from Silviculturist, Forest Research Institute, Dehra Dun, was tried at Chikalda, Pachmarhi, Supkhar and

Nagpur. At the first three centres the seed failed to germinate. At Nagpur 600 seeds were sown broad-cast on a prepared bed on 1st October. Germination commenced on 22nd October and was over by the 29th. Only 21 seeds germinated.

Balaghat.—A temporary nursery was made at Dhansura where 4,600 teak, 800 *Dalbergia latifolia* and 700 *Ougeinia dalbergioides* 'dona' (leaf cup) plants were raised at a cost of Rs. 32. In the Forest School nursery 15,000 'dona' plants of teak, *Dalbergia latifolia*, *Acacia catechu*, *Eucalyptus* spp., *Cassia siamea*, *Lagerstroemia flos-reginae*, *Anacardium occidentale* and *Artocarpus integrifolia* were raised. A number of these were sold and some given away free for Coronation planting, etc., and the total revenue from the nursery was Rs. 400.

Bilaspur.—Numerous plants were raised at the Deopur nursery, mostly in beds for stumps, and some in "doras". The species were teak, *Dalbergia sissoo*, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Gmelina arborea*, *Ougeinia dalbergioides*, *Cleistanthus collinus*, Bamboo, and *Cassia* spp.

North Chanda.—Nurseries at Ghantachowki, Moharli and Rambagh supplied all the stumps required for new plantations and replacement of casualties. The root system of most of the pricked out seedlings gets deformed and consequently they do not make good stumps. Pricking out is therefore to be discontinued.

Saugar.—Seeds of teak from Nilambur, Allapilli, Bori and Ramna forests (one maund of each), *Pongamia glabra*, *Cassia siamea* and *Eucalyptus citriodora* were sown broad-cast in separate lots in the Ramna nursery with the following results. Germination of teak seed from outside was on an average 50 per cent. (Nilambur poorest and Bori the best); *Pongamia glabra* 60 per cent.; *Cassia siamea* in doras, 80 per cent. and *Eucalyptus citriodora* in doras, 40 per cent.

Yeotmal.—From the Umerda nursery 200 seedlings of *Dendrocalamus strictus* were transplanted over an area of 85 acres, in pits, at a total cost of Rs. 18, in June 1937. About 62 per cent. plants survived. These were mulched in the hot weather. Plants put out on sloping ground and under shade were more vigorous.

Besides, small nurseries were maintained in several divisions.

(v) Artificial regeneration including agri-silviculture.

(a) Plantations.

The important plantations made during the year are detailed below:—

Balaghat.—7 acres of mixed forest were clear-felled and planted up, 12'×12', with a mixture of teak, *Dalbergia latifolia* and *Ougeinia dalbergioides* 'dona' (leaf cup) plants in prepared pits, 6"×6". The plants are

reported to be doing well. 5 acres of forest containing *Bambusa arundinacea* were clear-felled and planted up with teak and *Dalbergia latifolia* 'dona' plants. Plants were weeded in the cold weather. Total cost of formation was Rs. 25.

$\frac{5}{4}$ acres of the school forest were clear-felled, staked $6\cdot6' \times 6\cdot6'$, and planted in July by the students with teak 'dona' (1,430), teak one-year stumps (1,430), *Dalbergia sissoo* 'dona' (575), *Cassia siamea* 'dona' (1,155) and bamboo seedlings (1,160).

Bilaspur.—23 acres were clear-felled in January 1937, felling débris (no bamboos) spread and burnt in May. 6,700 one-year old teak stumps put out $12' \times 12'$ in the third week of June. Results have been fair with average height, in March, $11\cdot2''$ —maximum 39".

21 acres of Central Provinces III quality mixed forest with scattered teak were clear-felled in January 1937, and debris including bamboos spread and burnt in May. 6,150 three-months old and 6" high teak 'dona' plants were put out $12' \times 12'$ on 22nd and 23rd June. Weeding was carried out as necessary and casualties were replaced; results have been good, average height in March 1938 being 30"—maximum 92".

A small experimental plantation was made with *Dalbergia sissoo* and *Dalbergia latifolia* 'dona' plants on sandy soil with almost no tree growth. Results have been good for sissoo, average height $10\cdot9''$ —maximum 30" but not very satisfactory for *Dalbergia latifolia*, the average height being 6"—maximum 16".

In Tenduchhua felling series, 4,450 teak stumps from one-year old seedlings were put out, $12' \times 12'$, towards the end of June and weeded as necessary. In March the average height was $10\cdot3''$ and maximum 47".

The cost of formation amounted to about Rs. 5 per acre, which is much less than at Nilambur.

Mandla.—In 2 acres of a blank area in *sal* forests *sal* seedlings are reported to have been transplanted and fenced.

North Chanda.—10 acres were clear-felled and debris burnt in May 1937. One chain wide strips were planted $9' \times 9'$, with stumps of teak, *Pterocarpus marsupium*, *Albizia lebbek*, *Chloroxylon swietenia*, *Lagerstroemia parviflora*, *Cleistanthus collinus*, *Dalbergia sissoo*, *Morus alba*, etc., in July. The area was weeded twice when casualties were replaced. *Lagerstroemia*, *Cleistanthus* and *sissoo* failed, but others are doing well.

Saugor.—*Pongamia glabra* seed was sown in 2,475 pits and nearly 14,000 teak stumps, 270 *Eucalyptus* and *Cassia siamea*, and 170 other seedlings were put out in suitable places over the entire coupe in July 1937. The result was a complete failure which is attributed to the growth of rank grass.

South Chanda.—303 acres were planted, 12'×12', with about 86,000 stumps and 22,500 seedlings of teak, after clear felling, exploitation and burning at a cost of Rs. 1,350. Eradication of *Mucuna prurita* and weedings were carried out in October and December.

Small plantations are being made annually in several divisions. Failures reported from several centres appear to be chiefly due to the unsuitability of the locality or faulty technique.

Pollinium angustifolium Plantation (*sabai* grass).—Experimental plantations are being made in Betul and Chhindwara.

(b) Agri-silviculture.

Very successful agri-silvicultural work is reported from Yeotmal. The agri-silvicultural work done during 1937-38 is detailed below :—

Amrati.—69 acres of *babul* buns were under regeneration at the commencement of the year and another 71 acres were taken up during the year. *Santalum album* seed was dibbled under 60 bushes of *Zizyphus jujuba*, *Zizyphus xylopyra* and *Gymnosporia montana*; results were disappointing. Sandal seed was also sown in the Meladari forest, 30 per cent. of which germinated.

Melghat.—The coffee plants are growing satisfactorily in areas leased out to the Roman Catholic Mission. Some areas covered with *Lantana* were given out to forest villagers for a period of three years for cultivation, on condition that they would plant cuttings of various forest trees between the lines of field crops. As far as the eradication of *Lantana* goes the method has been a great success but planting work has been neglected.

West Berar.—Teak sown in all the three localities failed completely probably due to very late (July) sowings. Other species tried were *Acacia arabica*, *Gmelina arborea*, *Albizia lebbek*, *Pongamia glabra*, *Anogeissus latifolia* and *Dalbergia latifolia*. All germinated satisfactorily except *Anogeissus*. *Azadirachta* was badly browsed as also *Gmelina*, *Albizia* and *Dalbergia* to some extent.

Yeotmal.—23,000 teak stumps and 3,000 seedlings were put out in gaps in plots 1 to 9 at Pandhardevi. The plots are now fully stocked. Teak occurring in *Acacia catechu* lines was freed, and *Acacia arabica* heavily thinned and pruned.

Half acre patches in each of the 18 plots at Borwadi were clear-felled in April, burnt in May and thoroughly cross-ploughed soon after. One-year old teak seed, which had been left in white ant nests for a month was sown on 31st May. Germination commenced in the first week of July and progressed satisfactorily. Gaps in the lines were filled up by transplanting superfluous seedlings from the previous year's plots. A

total area of 27 acres has thus been successfully regenerated in the last three years.

Agri-silvicultural work at this centre was commenced in 1925, and the experience gained at this centre is summarised below :—

Agri-silvicultural work should be undertaken only in localities where land-hunger is intense and cheap labour is readily available. The soil should be fairly rich and well-drained so as to yield a good harvest and eventually a good forest of at least Central Provinces IVa—quality. Cultivators should not be given more than 10 acres apiece. As a large outlay is involved in clearing the site and for subsequent weeding operations, fairly well-to-do tenants prove more successful than poorer ones. It is necessary to cross-plough the land in order to remove root stocks of trees and other herbage as this is not possible after the tree species have been introduced. Therefore during the first two or three years of the lease the cultivators should be allowed to grow only field crops. The obnoxious perennial grass *Ischaemum pilosum* can thus be completely exterminated. Forest species should be introduced in the third or fourth year and tended during subsequent years.

By far the most suitable species for the better soils is teak and *Acacia catechu* for the comparatively poor soils. Teak can be easily introduced as stumps from one year old seedlings. A nursery of about 1 acre for 500 acres to be planted up is enough and should be started in the third year of the lease to get stumps ready in the fourth year. But should it be found more convenient to grow a crop by direct sowings, teak seeds kept in white ant nests for a year after collection should be used as these germinate readily when sown thickly in lines a few days before the monsoon sets in.

Germination of the seed is not very good in the first year, but if the seed is left undisturbed much of it germinates in the second year. *Acacia catechu* seed should be sown after the rains have well set in. Germination is as a rule good and replacement of casualties is not necessary.

61 acres of fairly well stocked mixed forest of Central Provinces IVa to III quality was clear-felled at Kinwat in January 1937. The cut material was collected in small heaps on the big stumps in February and burnt in April-May. The soil was thoroughly cross-ploughed and harrowed. Weathered teak seed was sown in lines 6' apart towards the end of May. Two lines of cotton seed were sown between the teak lines. The plots were weeded in August, September and October. These operations have cost nothing to the department and in fact yielded a small profit.

The *rab-cum-taungya* method of restocking described above is proving very successful and may with advantage be tried in other divisions where agri-silvicultural work is in progress.

(vi) *Reclamation, afforestation and arboriculture.*

Reclamation.—In the *Pinus longifolia* plantations, at Supkhar, in which *sal* roots were not grubbed out at the time of formation, the overhead cover of the conifer is helping the *sal* saplings to establish themselves indicating that heavy shade does act as a successful frost-screen.

Of other areas open to reclamation, extensive blanks in *sal* forests are gradually being stocked by root suckers of *Diospyros melanoxylon*, and the numerous hills in Berar which have become bare as the result of heavy grazing.

Afforestation.—Several areas along the main rivers of the province are gradually getting denuded due to gully-erosion. The scrub jungle forming part of the catchment area of the Telinkheri lake in Nagpur is being placed in charge of the Silviculturist for afforestation with more suitable species.

Arboriculture.—Arboricultural work is primarily the concern of the Agricultural Department. The part played by the Forest Department only consists of propaganda to make the public conscious of the necessity for a picturesque environment for its general well being, and to afford the necessary facilities to attain this—in other words, to make the people tree-minded.

The Silviculturist has started a small nursery at Nagpur, where suitable plants of ornamental, flowering and shade trees, indigenous as well as exotic, are being raised and offered for sale at cost price.

(vii) *Tending.*

(a) *Thinnings in young teak—a suggestion.*

The coppice regrowth of teak in clear-felled areas is extremely irregular. Variation in size is primarily due to the varying vigour of the parent stools of seedlings, saplings, poles, mature and overmature trees. Grade-thinnings, which have crown classification as their basis, are impracticable. Similarly the extremely varied nature of the crop precludes the possibility of purely mechanical thinnings.

A new method of thinning has been worked out to suit these types of forest. It is based on what are known as *Freidurch-forstung* (Free thinnings), or to use a more expressive phrase, *individual stem silviculture*. It is applicable to any young teak forest without regard to its quality, age or stocking density, although the ultimate aim is to obtain a uniform mature crop.

It should be possible to find out, roughly (by reference to any suitable yield table if available, or by personal experience) how many uniformly

spaced *elite* stems should be left at the first thinning so that when properly tended they will yield the requisite number of trees at maturity. It will be found that this number will generally be between $3N$ and $4N$ for the low forests and between $4N'$ and $8N'$ for the high forests where N & N' represent the numbers at maturity.

Having obtained a rough idea of the number of *elite* stems the (approximate) average diameter of the trees of the top-height class, i.e., the predominant and codominant trees as adjudged from their heights compared with those of the neighbouring trees should also be determined. The number of *elite* stems to be retained for this average diameter should next be estimated by observations or checked against a suitable yield table. The double check will give a fairly accurate idea of the number of *elite* stems to be retained at the first thinning. From the number thus obtained the average espacement should be worked out from the formula*, $-d^2 = \frac{A}{N}$, where d is the distance between adjacent trees, A is the area and N is the number of stems. Once the value of d is obtained in this manner, the thinning operations become more or less mechanical.

Observations made so far justify the following tentative conclusions :—

Species of climbers.	Success under above treatments.			Remarks.
	(i)	(ii)	(iii)	
<i>Acacia caesia</i> & <i>A. pennata</i>	Nearly 100% nil	..	..	In North and South Chanda.
<i>Bauhinia rufa</i> . .		Partial	Slightly better.	When climber is very thick much deeper digging required.
<i>Butea superba</i> . .	75%	90%	..	In North Chanda.
<i>Calycopeteris floribunda</i> .	95%	100% (90%)	..	Do. (In South Chanda.)
<i>Combretum decandrum</i> .	..	100%	..	In South Chanda.
<i>Cryptolepis buchananii</i> .	..	Nearly 60%	..	Do.
<i>Millettia auriculata</i> . .	..	100%	..	Do.
<i>Ziziphus oenoplia</i> (a thorny shrub).	..	100%	..	Do.

* or $d^2 = 50, 312/N$ (approximately) where d gives the distance in feet. The formula assumes that the trees are situated at the vertices of equilateral triangles which is a better approximation to natural conditions than the assumption that trees occur at the corners of squares.

(b) Climbers and Weeds.

Climbers.—The five-year climber cutting programme prescribed in many plans has not been found satisfactory as whenever the cover is open this results in the climber growing with greater vigour after cutting. Attempts are therefore being made to discover a more effective and yet inexpensive method of eradicating the most destructive climbers or at any rate keeping them in check. Experiments are being conducted in several divisions. Experience gained up-to-date is summarised below :

The most destructive climbers are :—

Acacia caesia, *Acacia pennata*, *Bauhinia vahlii*, *Butia superba*, *Calycopteris floribunda*, *Combretum decandrum*, *Cryptolepis buchanani*, *Milletia auriculata*, *Mucuna pruriens* and *Zizyphus oenoplia*.

The effects of three treatments have been studied, viz.—

- (i) Cutting 6" below ground level and covering loosely with earth.
- (ii) Cutting as under (i), but ramming earth firmly over the stump.
- (iii) Cutting as above, smearing the cut surface with kerosine and tar and then firmly ramming earth over the stump.

The following are only tentative conclusions and the experiments are being continued to obtain conclusive results. So far, treatment (i) kills only a few species, whereas (ii) gives extremely satisfactory results. There is practically no difference in the cost under these two treatments, but (iii) is definitely more expensive.

A feature of the year was the excellent climber cutting work done by forest guards while patrolling their beats.

Weeds (*Lantana aculeata*).—In accordance with the prescriptions of the Melghat working plan, *Lantana* was pulled out in the rains of 1935 and 1936 with the help of elephants in coupes I & II at a cost of as. 12 per acre. In 1937, *Lantana* was first burnt and then uprooted with the help of elephants, at a considerably lower cost of as. 6 per acre. But subsequent observations show that such treatment is not only an expensive operation but it also does not exterminate the pest, which reappears soon after with sufficient vigour to retard seedling reproduction. On the other hand it is observed that *Lantana* has almost completely disappeared from fire lines as a result of successive burns.

(viii) Mixtures.

Increasing attention is being paid to the retention of miscellaneous, soil-sheltering species in teak plantations. *Dalbergia latifolia* and *Ougeinia dalbergioides* are so utilised in Balaghat. In Bilaspur, trials

have been made with *Dalbergia latifolia*, *Pterocarpus marsupium*, *Gmelina arborea*, and *Swietenia mahagoni* but the results have been somewhat disappointing. The failure of these species is chiefly attributed to their slow growth and susceptibility to browsing. Better results are likely to be obtained by increasing the espacement of teak from $6' \times 6'$ to $12' \times 12'$ and thus allowing sufficient space for the coppice regrowth, which is comparatively fast growing, to become established. Suitable species from among this miscellaneous regrowth could then be favoured in subsequent cleanings to obtain a desired mixture. The common bamboo (*Dendrocalamus strictus*) can grow under the shade of teak, is readily saleable, and is capable of growing into a soil-sheltering under-storey. Trials have shown that this can be introduced by patch sowings and attempts are therefore being made to extend these operations.

(ix) *Underplanting.*

Experimental planting of teak and other species under a complete canopy of mixed forest was carried out over an area of four acres in the North Chanda division for the third year in succession. Observations in 1935 and 1936 plantations show that naturally the plants under shade are weak and lanky as compared with those in the open but the survival percentage is very high and the plants retain their leaves longer. Any deductions at this stage would be premature.

(x) *Silvicultural systems.*

In *Amraoti*, opinions seem to be divided as to whether understocked areas, containing teak or other species, should be subjected to improvement fellings, or to clear-felling and subsequent replacement.

In *Bilaspur*, experimental clear-fellings in *sal* regeneration areas show that such operations are unsafe as frost is a serious factor to be contend-ed with. Retention of a shelterwood is therefore advocated. The extent of cover retained will depend upon the susceptibility of the area to frost. 90 to 120 trees per acre ranging in girth from 1' to 3' are found to afford ample cover in average localities.

In *Hoshangabad*, the shelterwood system of regeneration is being replaced in frost liable areas by improvement fellings under which suffi-cient overwood is being left to provide protection against frost.

In *Melghat*, the teak forest taken up for conversion is too young and much young and middle aged growth is being sacrificed by adopt-ing a short rotation of 60 years.

In *North Chanda*, the advance cutting of bamboos to prevent the suppression of teak coppice after clear-fellings is silviculturally quite successful, though expensive. Established regeneration of *Pterocarpus marsupium* does not occur, and clear-fellings are resulting in the gradual

disappearance of this valuable species. As a safeguard, therefore, all sound trees up to 3' girth are being reserved. Experiments to introduce the species artificially are also being made.

In *Raipur sal* forests, which are seriously damaged annually by frost, the uniform system is hardly suitable : reservation of a shelter-wood to protect the young regeneration for a considerable time is indicated.

In *Saugor*, clear-fellings in the regeneration areas of the Ramna forest have been disastrous owing to severe frost damage to the young crop. The system of High Forest with Reserves under which a cover in the form of promising poles can be retained has therefore been prescribed. To save costs on subsequent weedings, advance planting in areas devoid of regeneration has also been resorted to.

(xi) *Miscellaneous.*

Fires.—Most of the fire lines in Balaghat are too narrow to stop a conflagration sweeping up a hill and there is little doubt that such fires take a heavy toll of *sal* reproduction and result in a retrogressive succession to a savannah type.

In Hoshangabad, to minimise damage from fires there is a growing tendency to admit grazing in regenerated areas as soon as the tree species have grown to a size when they cannot be damaged by cattle. In North Chanda division, the number of fires in recently regenerated crops has increased due perhaps to incendiarism.

Frost.—Mr. Harlow, Conservator of Forests, has recorded his impressions on the causes of frost damage and suggested certain remedies, in an article published in the Indian Forester for January 1937. The Provincial Silviculturist has also suggested in a small note (Indian Forester, 1937, pp. 578-79) a possible method of preventing frost damage by inducing the circulation of stagnant cold air by cutting a series of strips across frost-liable depressions, and running in the direction of the prevailing wind in the locality.

Grazing : Experimental work.—The grazing plots in Saugor and Yeotmal were maintained and the data from the latter were analysed by the Central Silviculturist, Dehra Dun. The analysis shows that the divergence in the yields under identical treatments is so great as to have completely swamped the effect due to treatment alone. It is not possible to deduce any reliable conclusions regarding the optimum grazing incidence or grazing-closure cycle. There have, however, been some definite observations of interest, viz. :—

- (i) *Cassia tora*, an invasive pest of the pastures can be suppressed after a year's closure and more or less completely exterminated after 2 or 3 years' closure.

- (ii) *Andropogon contortus* (Spear grass) which is disliked by cattle, can be gradually replaced by the palatable grass, *Ischaemum laxum* (*sheda*), by repeated closures.
- (iii) Heavily grazed pastures recover sufficiently after 2 or 3 years' closure and grass cuttings after the seed is shed, and that closures beyond 4 or 5 years instead of further improving the pasture actually lead to an increase of the coarser grasses like *Anthisteria ciliata* and *Apluda varia*.

New experiments are about to be laid out, in collaboration with the Agricultural Department to find out the best method of improving the 'Open Pastures', i.e., areas in which the primary demand is for grazing.

Forty acres of a permanent pasture land and 5 acres of a permanent grass reserve have been selected for the purpose and the preliminary investigation to assess the trend of variations in the locality has just been completed. The entire areas has been grid-surveyed, i.e., divided into one chain squares.

In Bilaspur, coupes of certain felling series were opened to grazing of cows for a part of the year to minimise fire-hazard, as also to help the regeneration to get through. The results were very gratifying.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plans.

The (10-yearly) revision of the following working plans was completed during the year :—Yeotmal, North Raipur, Hoshangabad, Buldana and Seoni. Besides, the revision of the Chhindwara and Jubbulpore plans was also nearing completion towards the close of the year.

The plans of Old North Mandla, Raipur Mixed, North Chanda, Ahiri Leased Range and Melghat were published during the year. Many detailed amendments were issued to several of the current plans and the grazing settlements accompanying them to bring their prescriptions up-to-date, and to redress reasonable grievances of the agriculturists in regard to grazing and extraction of certain minor products.

(ii) Statistical.

Sample plots.—Four new sample plots in young teak plantations were laid out during the year, thus bringing the total to 117. The sample plot data collected during the last twenty years were examined

with a view to find out if local yield tables for *sal* and teak could be compiled. It was found that this would not be possible for some time, as data for certain ages and qualities are still very meagre. Meanwhile, two graphs have been prepared for teak plots, one showing crop diameter and the other crop height against age.

Experimental plots.—Besides preliminary operations in the Nagpur pasture experiments, mentioned before, the only other important investigation started during the year was a detailed experiment in Nagpur-Wardha division to determine the best method of tapping *Sterculia urens* trees for their exudation known in trade as gum Kareya. 196 trees are being tapped at fortnightly intervals to study the effect on the production of gum of :—

1. 4 kinds of blazes, *viz.*, (1) notches with axe or *chheni*, (2) horizontal or slanting slits, (3) oblong blazes and (4) triangular blazes.
2. Aspect.
3. Girth of trees.
4. Continuous tapping and tapping in alternate years.

Tapping commenced in October and was stopped in June. The figures of yield of gum have been sent to Dehra Dun for analysis. It was noticed that the gum is eaten with avidity by monkeys.

III.—MISCELLANEOUS.

The office of the Silviculturist was held by Mr. K. P. Sagreiya, Deputy Conservator of Forests, throughout the year and he toured for 101 days. The post of the Assistant Silviculturist remained vacant.

A number of photographs were added to the collection during the year. All important publications were ledger-filed by cross references or insertions of cuttings. A manuscript catalogue for the provincial forest library is nearing completion.

COORG.

I.—EXPERIMENTAL SILVICULTURE.

Seeds.

Germination test of Santalum album.—Seeds with pulp and without pulp were sown in nursery beds in the 3rd week of May 1937; the latter

germinated much more than the former, their corresponding percentages of germination being 71 and 23 respectively. This corroborates the previous year's results.

Now it is the practice in Coorg to remove the pulp of seeds before sowing in all sandal regeneration operations.

Germination test of evergreen species.—Seeds of *Hopha parviflora*, *Cedrela toona* and *Diospyros malabaricum*, sown in nursery beds at Makut, failed to germinate owing to unsavourable weather conditions. Flowering and fruiting of evergreen species was generally bad during the year.

Sagera.—Of the seed received from Dehra Dun the first 200, sown in nursery beds at Makut on 22nd June 1937, proved a complete failure. A second lot of 100 seeds were again sown on 4th January 1938 and the bed was watered daily. On 7th March 1938 four seeds only germinated, but the seedlings died immediately after.

*Oil palm (*Elaeis guineensis*).*—310 seeds were sown on 2nd March 1937 at an espacement of 6"×6" in the nursery at Makut. Germination commenced on 3rd May 1937, and was 68 per cent. by 5th July 1937. Germinating seeds were transferred to nursery beds where they were planted at an espacement of 12"×15", and the seedlings came up well.

*Tung (*Aleurites fordii* and *Aleurites montana*).*—The results of germination for 1937 and 1938 are given below :—

Locality	1937.				1938			
	<i>Aleurites fordii</i>		<i>Aleurites montana</i>		<i>Aleurites fordii</i>		<i>Aleurites montana</i>	
	Seeds sown	Germi-nation	Seeds sown	Germi-nation	Seeds sown	Germi-nation	Seeds sown	Germi-nation
		Per cent.		Per cent.		Per cent.		Per cent.
Ijgoor . .	616	55	532	61	1,000	55	1,000	33
Meenkollil . .	600	68	640	50	1,000	58	1,000	25
Annala . .	676	64	628	60	1,000	40	1,000	13
Tittimtil . .	634	35	432	12	1,000	25	1,000	0
Irumani . .	408	66	288	20	..	..	..	..
Bulecone . .	600	78	570	25	..	..	..	..
Nyerholo . .	.	..	..	..	1,000	62	1,000	33
TOTAL . .	4,014	65	3,740	40	6,000	43	6,000	23

Both in 1937 and 1938 the percentage of germination were better in the case of *Aleurites fordii* than *Aleurites montana*.

Germinating seeds were transferred to baskets and in all 3,854 basket plants were raised during the year. 1,533 basket plants were planted out in the field over 12 acres and 1,210 basket plants were supplied to outsiders.

Sandal regeneration experiments.

Propagation centres and individual basket fences.—No new centres were opened during the year. 469 propagation centres and 674 basket fences of previous years were maintained. There are plants in most of the centres and the best plant measured 11' 6" in height and the minimum was about 12", the latter being mostly replacements during the year.

Artificial regeneration.

Results obtained from 3 years' experiments carried out during 1935, 1936 and 1937 on pre-monsoon stump-planting at fortnightly intervals starting from the middle of April and continuing till the beginning of July have indicated so far that the best date for stump planting in Coorg lies between the 25th April and the 10th May. The survival and height growth of those plants put out on 15th April, 1st May and 15th May were decidedly better than those put out after 15th May—the superiority having been maintained in the 2nd and 3rd years also.

Experiments in Nagerhole and Devamachi where stumping and sowing were done at stakes on different dates indicate that early sowings have given a fair percentage of germination at stakes than those sown late in the year, the percentage varying from 52 to 10. The height growth of plants was also better in early sowings, but cannot be compared with plants raised by stumping where the survival percentage is much higher and the height growth is almost double.

The method of raising Teak plantations in Coorg has now changed from the old practice of sowing at stakes to early (pre-monsoon) stump planting.

Effect of taungya (kumri) crops on the growth of teak in a plantation.—The experiment in Devamachi 1936 area with cover crops of paddy, *ragi* (*Eleusine coracana*), *dal* (*Cajanus indicus*), and *Tephrosia* (with controls for each) was under observation. Details of percentage of survival and mean height at the end of the 2nd growing season indicate that in many cases the percentage of survival and mean height growth are better in the control. The height growth of plants in the plot kumried with *ragi* (*Eleusine coracana*) is poor.

This corroborates the previous year's results about the retarding effect of the field crop on teak.

Best planting distance of teak and its effect on the height growth of teak plants.—(a) Observations in experimental plots Nos. 27 and 33 in Nagerhole and Devamachi 1935 areas were continued. Three espacements were introduced, i.e., $6' \times 6'$, $4\frac{1}{2}' \times 4\frac{1}{2}'$ and $3' \times 3'$. As this experiment is a long term one, it is yet too early to offer any remarks.

(b) This year another experimental plot was opened in Devamachi 1938 regeneration area and the above three espacements were introduced. The area has been successfully stump planted with teak.

Cover crop: (a) *Tephrosia candida* (*Boga*) introduced in the 2nd year of a teak plantation (E. P. Nos. 24 and 51, Nagerhole and 28, Kallalla).—These areas were dibbled with teak and buried in the 1st year of formation and *Tephrosia* introduced in between tenk in a quincunx manner in the second year. Casualties were not replaced. In all centres the growth of *Tephrosia* was good and these were cut back to allow teak to grow uninterrupted.

A careful scrutiny of the results obtained so far (including 1938 measurements) reveals that the percentage of survival in all cases is better in the control than in the *Tephrosia* strip. As regards development of plants it is noticed that the height growth of plants in *Tephrosia* strips is better in the experimental plots in 1931 areas, whereas in 1935 area the growth of plants is better in the control strip.

The plants in the *Tephrosia* strip are lanky and those in control are stout and slightly branched. There is no *Lantana* or other woody undergrowth in the *Tephrosia* strip and the floor is fairly clean.

It is indicated that if *Tephrosia* is introduced after giving a good start to teak it keeps down weedgrowth and maintains a fairly clean floor, and the teak plants are less branched developing clean stems.

(b) *Tephrosia* was sown in grassy and non-grassy areas in the third year of a plantation to study its effect on grass and development of teak (E. P. No. 56, Nagerhole):—

The results are as follows:—

Germination of *Tephrosia* was poor and the development of those successful was also not satisfactory. Hence it is difficult to draw any conclusion from this experiment.

*To compare the effect of the following on the development of teak in the first year of formation:—(a) Stumping and weeding; (b) stumping and scraping; (c) stumping and kumri with ragi (*Eleusine coracana*); (d) sowing and weeding; (e) sowing and scraping; and (f) sowing and kumri with ragi (*Eleusine coracana*).*—In the strips where weeding and scraping was done, no other treatment was carried out during the year.

In the bit *kumried* with *ragi* some backward plants were weeded and woody under-growth interfering with teak were cut down. Measurements of plants in the plot opened in Ammale 1936 area, Frascerpet Range, were recorded and abbreviated results are given below:—

Locality.	E. P. No.	Treatment.	Per cent. of survival.	Mean height in inches.	REMARKS.
Ammale 1936 area	45	Stumping wooding.	90.4	83.93	After two grow- ing seasons.
		Stumping scrapping.	95.5	105.44	
		Stumping <i>kumri ragi</i> .	93.0	49.47	
		Sowing and weed- ing.	95.5	70.78	
		Sowing and scrap- ing.	92.7	79.00	
		Sowing and <i>kumri</i> <i>ragi</i> .	92.7	12.61	

Stumping has given best results both in survival and height growth. The growth of plants in scraped strip is very good. Even in the strip sown the growth of plants in scraped bit is better than the other two. This indicates that stumping is good, and also that scraping in lines assists the development of plants to a great extent. Further it is observed that the *taungya* crop of *ragi* is found to retard the growth of young teak to a great extent.

Effect of underplanting teak areas with Dalbergia latifolia (E. P. Nos. 37 to 39, Mallipatna).—Observations in 1933, 1934 and 1935 areas were continued. About 60 per cent. of the plants are established and there are some natural plants also coming up well in these plots. The plants are whippy and the best one is 7' high; they are now struggling in midst of teak which in some cases are more than 20 feet in height.

Effect of burning and cutting back of teak plantation in the second year of formation.—Experimental plot in Nagerhole 1935 area was under observation. Results of height growth indicate that burning or cutting back or both are, after two years, all inferior to no burn and no cutting back. The weed growth, however, is kept down by this early burning, thereby freeing teak seedlings in the early stage from competition.

Teak stump origin experiment.—Stumps prepared from seedlings raised from Nilambur and Mysore seed origins were planted in

Nagerhole 1935 area (E. P. No. 25). Results of plant measurements are analysed below :—

Year of formation.	Origin.	On 28th March 1937.		On 24th March 1938.	
		Per cent. of survival.	Mean height.	Per cent. of survival.	Mean height.
1935	Nilambur . . .	87	68.37	80	125.26
	Mysore . . .	78	47.01	80	89.86

The above shows that Nilambur stumps have given better results both in survival percentage as well as in height growth than stumps of Mysore origin.

Teak seed origin experiment.—Seeds of Coorg (local) and Mysore origins were sown on 24th April 1935 in the experimental plot (No. 24) in Nagerhole 1935 area. At the end of three growing seasons their relative survival percentages were 79 and 70 and mean heights 40" and 42" respectively without showing any significant difference so far between the two origins.

Miscellaneous.

To study growth of sandal in plantations with teak as host.—The stocking and growth of sandal in experiment No. 7 of 1934 in Tittimatti is good with an average height of 10 feet and girth of 8 inches. The plot was thinned during the year.

Sandal sample trees have been selected in all working centres of sandalwood tract and their girth measurements and condition were recorded. Old sample trees of sandal, teak and evergreen species are also being maintained.

Dehra Dun (F. R. I.) sample plots.—The Central Silviculturist with a sample plot party laid out, during November-December 1937, a number of plots (about 40) to study growth increment in teak, sandal and evergreen species, to determine the period and the best intensity of thinning teak plantations along with the botanical study (by the Forest Botanist) in case of linear plots in Makut Forests.

A sandal wood tree increment plot was opened at Meenkoli in older plantations to determine (i) the period sandal takes to reach the present exploitable size of 40" girth, (ii) the financial rotation and (iii) to find out when rot generally comes in and starts depreciating the value of the tree.

A linear plot 7 furlongs in length was laid out along Meeukolli road, one chain on either side, and 357 trees in this arc under observation. The trees have been measured for girth, height and crown spread and the situation of each tree is also noted.

Linear sample plots in evergreen forests.—Two plots were laid out in Makut Range to determine (1) growth increment of evergreen species, (2) botanical identification and (3) the differences in types of forest for Working Plan purposes.

Trees 4" diameter and over at breast height were measured and 2,250 such trees in one plot and 1,685 in the other were numbered with zinc plates.

Sandal spike disease.—Some 387 attacked trees, noticed in different plantations or village sites were treated with Atlas and killed (and uprooted in a few cases).

Sandal spike incidence in Hudgur 1928 plantation.—Except for five incidences in August 1936 no fresh attack has occurred. The observation plot and sandal area in the vicinity are inspected periodically for spike attack and so far none could be found.

Badabanalli sandal observation area of 1936.—This experimental area was maintained during the year and in plot 6, 500 bamboo seedlings and 500 *Cassia siamea* plants were introduced in July 1937, only 105 of the former and 165 of the latter are now surviving. Regrowth of *Lantana* was completely uprooted in plot 4, and the area was successfully fire protected. In November 1937 twelve cases of spike were noticed in plot 4. All these trees come within a radius of 5 feet and they may be the sprouts of the same parent tree, most probably root suckers. All were promptly treated with Atlas. Besides, there were 44 incidences of spike in the adjoining sandal area and the trees were treated with Atlas and killed. This area is open to grazing and considerable damage is caused to sandal plants by village cattle.

From the results of enumeration, it is observed that there is considerable increase in the stocking of sandal. The stocking has increased slightly in the plot where *Lantana* was uprooted.

Teak defoliation experimental areas in South Coorg.—Periodical measurements of trees in these areas were recorded during the year. In Tittimatti, defoliation was noticed in all plantations and in some areas in a severe form. In Nagerhole, the defoliation was rather severe, but not so in Frascerpet and in the teak plantation at Malkut.

Gap regeneration in the Closed Working Circle (Nagerhole).—Three spots, each 0.3 to 0.5 of an acre, were clear felled, burnt, the gaps were staked 6'×6' and planted with teak stumps in the third week of April 1938.

Tung cultivation (Aleurites fordii and Aleurites montana).—Plantations have been opened in six localities. Results in respect of survival percentage and height-growth are quite encouraging so far. The plants were measured in June this year and the best plant (*A. montana*) in Iygoor was 7' 1" in height and *A. fordii* 5' 3". The plants are growing vigorously.

Oil palm area (Elexis guineensis).—An area of about two acres near Urti was clear felled, and rubbish burnt. Palm plants were planted in the 2nd week of July at an espacement of 20'×20'. The area was kumried with hill paddy, casualties in palm were replaced and at the end of the year the survival was 51 per cent. The tallest plant is 12" high and the plants are not looking happy. They were shaded during the hot weather.

Manurial demonstration on tung (Aleurites fordii and Aleurites montana).—The object of this experiment is to ascertain the response in growth and yield from Sulphate of Ammonia, Concentrated super-phosphate and Muriate of potash.

Eight plots were opened, four for *Aleurites fordii* and four for *A. montana* in Iygoor 1937 area. Four treatments were applied, one being the control. (Fertilisers were applied on 7th June 1938.)

Regeneration work in evergreen (rain) forests.—Experiments to study the survival, development and increase of natural regeneration of valuable species when tended according to prescriptions of the working plan, and secondly to watch the survival and development of artificially introduced valuable species such as *Hopea*, *Artocarpus*, etc., have been in progress and observations were continued during the year.

Sample strip enumerations indicated that regeneration of *Vateria indica*, *Hardwickia pinnata*, *Artocarpus hirsuta*, *Dipterocarpus indicus* and *Palaquium ellipticum* is found in abundance,—*Vateria* being the predominant species. As regards artificially introduced transplants of *Hopea*, survivals of previous year are coming up well and the best plant is 3' 6" high. Six Burma bamboo outtings are doing well.

Artificial regeneration of Hopea parviflora under shade in forest openings.—Out of 530 seedlings planted in previous years 365 were surviving, i.e., 73 per cent. A further opening was given during February 1938 and casualties were also replaced. The plants are coming up well and the best plant is about 18" in height.

Frill girdling and poisoning with sodium arsenite.—The experimental area (Urti coupe) was under observation during the year. Concentrations of poison used were $\frac{1}{4}$, $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{6}$ of solution as originally supplied; and the girth classes were 2' 6"—4', 4"—5' 6", 5' 6"—7' and 7' and above. The poison was applied during October and November

1936 and in all 455 trees are under observation. So far girdling and application of $\frac{1}{10}$ concentration of solution seems to have had not much effect. In the other three, more than 50 per cent. of the trees are dead. Girths seem to be of no consideration as regards the effect.

The natural regeneration in this area is splendid and the plants are growing vigorously. The gradual opening created, as a result of the slow process of dying of the overwood trees, appears to be the most suitable method for the development and increase of natural regeneration of valuable species in these evergreen forests.

MADRAS.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Results and indications.—Space does not permit here mentioning all items of work undertaken. For fuller information the "Annual Report on Silvicultural Research in the Madras Presidency for the year 1937-38" published separately should be consulted.

A large proportion of the work done has been small scale stage I(a) experiments and routine seed germination and weightment tests. The most important results obtained during the year are probably :—

- (a) The extension and great improvement in the regeneration of dry fuel forests by the "rab" method and its combination with the raising of field crops (*rab-cum-kumni*). In many districts with the most unpromising soil and climatic conditions success with this kind of work is now routine and height growth of 2 to 5 feet in the first year is common.
- (b) Further demonstration of the great benefits obtained by soil working by forking in the early stages of the "rab" regeneration of dry fuel forests.
- (c) In very poor areas in such forests, the successful raising of plantations for manure leaves of *Cassia siamea* and *Poinciana elata* and plantations for tan bark of *Cassia auriculata* (Avaram).
- (d) Continued success in the control of new outbreaks of the spike disease of sandal.
- (e) Progress towards the identification of the insect or insects responsible for the spread of the spike disease of sandal. It has also been proved that it is an insect that operates at night and between August and November as its main infective season.

- (f) The conclusion of the investigations into the best date of stump planting and best size of stumps to use for most of the important local species.
- (g) The further collection of statistics of teak stump production in nurseries and the methods by which economies can be made. In conjunction with this is the demonstration of the fact that in years of shortage (due to bad seed years), undersized stock in the nursery can be developed into good stock for the following year.
- (h) The controlling of the mahogany pests by silvicultural methods of using shade crops and segregation is showing marked success.
- (i) Analysis of data for the compilation of new yield tables for Nilambur teak has shewn that the number of stems, basal area, and volume, per acre, when expressed in terms of "top" height are independent of age and quality; accordingly, a table of thinnings has been prepared which will be of the greatest use to district officers.

Financial aspect of silvicultural research.

(a) *Teak Plantations*.—The revolutionary change in the technique to raising plantations by pre-monsoon stump-planting in crowbar holes and the improved weeding and tending methods have reduced the cost of formation by Rs. 10 to Rs. 15 per acre, amounting to an annual saving of over Rs. 17,000 in the Province.

These improved methods of formation, tending and thinning will (according to all present indications) lead to a reduction of the plantation rotation of about 10 years, which means a great increase in the potential value of the present plantations.

Spike disease of sandal.—By the control operations done by the research staff in North Salem division during the past 5 years, an average annual loss of Rs. 21,000 is claimed to have been averted in one district alone.

(ii) Natural Regeneration.

By Seed.

Experiments with *Hopea parviflora*, *Calophyllum elatum*, *Diospyros malabaricum* and *Mesua ferrea*, so far show that clearing undergrowth and raking the soil under mother trees are not beneficial in inducing natural regeneration. The indication is not conclusive yet.

Canopy opening over young regeneration of *Hopea parviflora* was found to be very beneficial but produced no notable effect on *Mesua ferrea*. Further experiments with *Palaquium ellipticum* have been started.

Experiments have been started to determine why at Nilambur some mature trees of *Swietenia macrophylla* have a dense mass of natural regeneration under them while other trees produce none. Results so far show that seed production, seed fall, and germination are normal and that the seedlings survive the first hot weather. It remains to be seen when and why this regeneration disappears.

Partial canopy removal over dense regeneration of *Pterocarpus santalinus* produced a very beneficial effect in spite of 2 years' unfavourable climatic conditions.

By Coppice.

Experiments in the dry fuel forests of Chittoor district showed that the ordinary operation of coppicing causes a mortality of approximately 9 per cent. of the stools and that trimming of the stools is definitely harmful in such areas.

A large scale (30 acres) experiment was done towards the effect of height and method of coppicing teak on the mortality of stools. It is of interest to note that so far mortality with this species has been negligible (about 1 per cent.) ; and that the main coppice shoots come from very near the ground level irrespective of the height of coppicing.

(iii) Seed.

Seed pre-treatment.—Routine pre-treatment tests were done with 27 species. Treatment with boiling water improved the germinative capacity of *Acacia auriculiformis*, *Acacia cyanophylla*, *Acacia baileyana*, *Acacia decurrens*, *Bauhinia purpurea*, *Pinus longifolia* and *Acacia dealbata* but was harmful for nearly all other species tried. Soaking in cold water was beneficial to *Gluta travancorica*, *Pterocarpus santalinus* and *Xylia xylocarpa*, being very marked in the case of the *Pterocarpus*. Concentrated sulphuric acid hastened and greatly improved the germination of *Cassia fistula*, *Cassia auriculata* and *Cassia marginata* while fermenting greatly improved that of *Terminalia chebula*.

Seasonal collection.—Tests made with 10 species again showed no definite variations in germinative capacity throughout the fruiting season.

Seed storage.—Routine tests were made with 33 species to determine the longevity of the seeds stored in different ways. (Vide results in the full Annual Report.)

Seed weighments.—Routine tests were carried out as usual. (*Vide* results in the Annual Report.)

Sorting seed by size.—Previous years' results that the sorting of teak seed by size is not justified economically were again confirmed. Tests with seeds from small immature, normal mature, and large over-mature seed-bearers with 4 species showed no appreciable differences in germinative capacity, or height growth of the resulting seedlings. Large scale experimental plots have been established to test the effects in later growth.

Seed origin.—There are two large scale long term experimental plots, each 4 years old. In the Nilambur plot, 20 of the 24 sub-plots were given a 50 per cent. mechanical thinning and were formed into 20 sample plots. This thinning at the age of 4 years is in accordance with the proposed prescriptions of the working plan, under revision.

(iv) *Nursery Work.*

In evergreen nurseries protection by sheltering from the very heavy rain of the south-west monsoon resulted in a much higher percentage of survivals with *Artocarpus hispida*. In the hot weather, seedlings of *Hopea parviflora*, *Diospyros malabaricum*, and *Cedrela toona* benefited greatly by shade in the nursery.

An experiment on nursery watering in a dry fuel area showed again that watering should first be very light until germination is over and increased thereafter.

Work on different nursery methods for raising teak stumps confirmed previous years' results that for 1 acre of plantation at a 6'×6' espacement, the best outturn of good stumps is obtained by sowing seed at the rate of 20 to 30 lbs. per standard 40'×4' bed and doing no pricking out of seedlings at all.

Further experiments also showed that if owing to a poor seed year and consequent shortage of stumps, the undersized stumps have to be used, they are best put back into the nursery beds as stumps for a second year. At the end of the second year some 60 per cent. (as against 70 per cent. of the previous year) of them will have grown to the right size and they can then be stumped again and planted out.

Experiments to determine whether teak nursery beds deteriorate if they are used repeatedly and if their fertility can be maintained by artificial or green manures were continued. Results so far show slight deterioration by the 3rd year but an increase of 18 per cent. (as against 5 per cent. in the previous year) in the utilizable stumps produced in the beds manured with wood ash and leaf mould.

(v) *Artificial Regeneration.*

(a) Mixed deciduous timber forests.

As regeneration of this type of forest by small gaps has definitely failed, experiments have been started in the regeneration of such areas by raising a valuable crop under the comparatively worthless shelter-wood. These experiments appear promising at present with a definite indication that under these conditions direct sowing is unlikely to succeed owing to drip. Several valuable species have however been raised by transplanting or stump planting. It is however too early to give definite results.

Comparison of sowing, transplanting and stumping.—Previous years' results were confirmed and showed that for teak, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata*, *Terminalia paniculata*, *Schleichera trijuga* and *Artocarpus hirsuta* stump planting is the best of the 3 methods while for *Xylia xylocarpa* direct sowing is to be preferred. *Pterocarpus dalbergioides* and *Swietenia macrophylla* do best by transplanting.

Optimum season for stump planting.—The majority of the investigations into the best date of stump planting principal species (most of which stump well) which have been going on during the past 6 years at 5 centres have now been concluded.

Detailed results will be found in the full report but the general conclusions are :—

- (a) In districts having a west coast type of climate, the principal species such as *Tectona grandis*, *Dalbergia latifolia* and *sissoides*, *Pterocarpus marsupium* and *Terminalia crenulata* can be stump planted before the monsoon breaks.
- (b) Except in unusually hot and dry seasons, this early stump planting gives a sufficiently good stocking (often much better than early June planting) and a great gain in height growth as compared with normal early June monsoon planting.
- (c) Success is not dependent on what is generally considered "good planting weather".
- (d) The great advantage given by the start the teak or other species get over weeds or field crops more than outweighs any risk of poor stocking, and this risk can be insured against by providing a reserve of plants for stumping in early June if the necessity should arise.
- (e) The best dates of planting each species at each centre have been provisionally indicated to be confirmed by further experiments,

District experimental work in Kurnool West division over the past 3 years shows that teak is best stump planted about 3 weeks to a month before the rains set in. It is emphasized that the best date of stump planting is essentially a local problem and each district must do its own experiments and obtain its own local data.

Stump planting—effect of age and diameter of stumps.—As previously reported teak stumps of 0·4" to 0·8" diameter at the thickest part gave the best results though stumps of 0·3" to 0·4" diameter are definitely "usable" in the event of shortage of the larger stumps though they do not give as good results.

Work with *Dalbergia latifolia* again showed that 2-year old stumps are better than 1-year old ones and 0·2" to 0·6" diameter is the best range of size. For *Pterocarpus marsupium* results indicate that the larger stumps of 0·4" to 1·0" diameter give the best results. Results for *Terminalia crenulata* show 0·4" to 0·8" diameter to be the best size, and for *Artocarpus hirsuta* within the range experimented with, the bigger and older the stumps the better the results.

Stump planting—pits and crowbar holes.—Experiments in stump planting teak in pits and crowbar holes in Kurnool West division during the past 3 years have shown that pit planting gives a 30 per cent. increase in height growth over crowbar hole planting but no advantage in survival percentage. But, in districts having a West Coast type of climate, no advantage at all is gained by pit planting.

Experiments in burying teak stumps when planting them compared with normal planting showed no differences for normal 1st June planting but buried stumps were definitely better in the case of pre-monsoon (April 1st) planting.

Storage of stumps—teak.—Experiments again showed that stumps can be successfully stored for 2 weeks before planting even in an abnormally bad year (climatically).

Irrigated plantations—teak.—Preliminary experiments in this subject show that irrigation by flooding (as in paddy cultivation) is more difficult and more expensive to do than irrigation by percolation from channels and gives no better results. Flooding also uses much more water.

Experiments were continued with *Syrietenia macrophylla* to determine the best espacement and the best shade conditions in which to grow the species. The season and incidence of its 2 great pests, the shoot borer and the collar borer, are also being determined under these various conditions. Shade very definitely reduces the incidence of the shoot borer.

A number of experiments were done to determine the best method by which to regenerate *Bambusa arundinacea* and *Dendrocalamus strictus*.

So far it appears that rhizome planting is more successful than transplanting or sowing.

A long term plot has been opened to determine whether the "figure" of *Terminalia crenulata (tomentosa)* is hereditary.

Casualty replacements in 2nd year teak-plantations.—Results so far indicate that few of these replacements survive and it is doubtful if they ever take their place in the main crop.

Effect of taungya (ponam) crops on teak plantations.—Previous work was repeated and shows that "ragi" (*Eleusine coracana*) retards the height growth of the teak by 40 per cent. in the first year while "dhall" (*Cajanus indicus*) has very little effect. This retarding effect of the *taungya* crop can be greatly minimized by early planting the teak.

Experiments were continued in the raising of semi-evergreens such as *Artocarpus hirsuta*, *Cedrela toona* and *Hopea parviflora* on areas which were probably originally evergreen and which through repeated shifting cultivation had gone deciduous. These experiments look very promising.

Entomological work in the control of teak defoliators and on the pests of mahogany was done by the Forest Entomologist, Dehra Dun.

(b) Evergreen rain forests.

All artificial regeneration work in evergreen forests (with the exception of experiments on raising evergreens after clear felling and burning) being mostly 'underplanting' has been dealt with under that head.

(c) Dry fuel forests.

Artificial regeneration of dry fuel forests by the "rab" method is being done on a larger scale each year with better results as the technique improves.

The greatest advance of the last few years is in the raising of these dry fuel species in conjunction with field crops such as *ragi* (*Eleusine coracana*), *castor* (*Ricinus communis*) and *cotton* (*Gossypium barbadense*).

Results of experimental and district "rab" work show that regeneration is best raised by direct sowing with most species. The best date of sowing varies greatly each year and the most practical method found is to sow early and to go on resowing at reasonable intervals until full stocking is obtained. (Seed is generally plentiful and cheap.) Transplanting and stump planting are in general not suitable to these species in this type of area.

The following species have given excellent results:—*Cassia siamea*, *Albizia lebbek*, *Azadirachta indica*, *Dolichandrone crispa*, *Acacia sundra*,

Albizzia odoratissima, *Pterocarpus santalinus*, *Albizzia amara*, *Wrightia tinctoria*, *Zizyphus jujuba*, *Pithecellobium dulce*, *Acacia ferruginea*, *Prosopis juliflora*, *Tamarindus indica*, *Acacia planifrons*, *Acacia arabica*, *Pongamia glabra* and *Cleistanthus collinus*.

A good burn coupled with soil preparation before sowing is essential for this work.

Soil working during the 1st year is very beneficial. It not only produces a much increased height growth but also enables backward plants to survive the hot weather.

Successful work has also been done in the raising of plantation to be worked for manure leaves by the planting of large shoot cuttings of *Poinciana elata*. The same purpose has also been served by direct sowing of *Cassia siamea* and *Poinciana elata* but of course such sowings take much longer to mature.

Stump planting of *Santalum album* has given a large measure of success and it has also been demonstrated that sandal stumps can be kept in air tight tins without deterioration for 3 weeks before planting.

Cassia auriculata (the 'Avaram' bark of commerce) has been successfully introduced by sowing in order to raise concentrated plantations of this species. Very little difficulty has been experienced even under the poorest conditions of soil and climate in our hottest districts.

(vi) *Afforestation.*

Experiments to examine the probability of reafforesting some of the more important catchment areas of the Nilgiris were continued and so far have given the following general indications as mentioned in last year's report :—

- (a) The moister localities can be easily stocked with willows by cuttings. They are frost hardy but need protection from browsing.
- (b) Small, close planted, concentrated plots do better than large areas of open planting owing to more efficient frost protection being possible.
- (c) Frost protection is best done by means of a complete pandal about 1' 6" from the ground and screened on the up hill side.
- (d) Nurse species can be raised as follows :—
 - (i) Broom by sowings.
 - (ii) *Buddleia* spp. by cuttings.

(iii) *Ligustrum neilgherrense*, *Rubus moluccanus*, *Rubus lasiocarpus*, *Myrsine wightii* and *Hypericum myorense* by planting stumps got from the forest.

(e) Tree species can be raised as follows :—

(i) *Acacia dealbata* by 2 year old large transplants.

(ii) *Cupressus macrocarpa* and *Callitris rhomboidea* by small transplants and these can come from the forest if necessary.

(iii) *Acacia melanorylon* and *Eugenia arnottiana* by mossed transplants.

(iv) *Mahonia leschenaultii* by stumps and these can come from the forest.

The indications of present knowledge are that a possible solution to the problem of afforesting the grass areas is—(a) fencing the selected area, and fire protecting it by a scraped and burnt fireline, (b) selecting 10' square patches inside the fenced area, (c) working the soil 1' to 1½' deep in such patches, and removing all grass and roots, (d) sowing broom seed broadcast in these patches, (e) covering the broom plants in the patches by a pandal in the first year as this has the effect of forcing the height growth of the broom, (f) then leaving the patch for the second year to establish itself, and (g) planting under this broom other frost tender tree species that are intended to be raised.

(vii) Tending, Thinning, Cleaning, etc.

Weeding practice.—Large scale experiments were done in continuation of the work of the past few years and results again conclusively confirm previous years' results that the slightly beneficial effect (if any) of forking as opposed to mamooty scraping as a weeding method in the first 2 years of a teak plantation in our better teak areas is in no way commensurate with the extra cost of forking.

Effect of a cover crop of Leucaena glauca on a teak plantation.—In an experiment in this subject the teak with the cover crop showed an increased height growth over that of the control teak at the end of the first year but this increase had greatly diminished to only 8 per cent. by the end of the 3rd year. The *Leucaena* was continuously browsed by deer and bison and was no use at all as a weed suppressor.

Thinning research—teak.—All plots in this subject were maintained.

Bamboos.—Experiments on the intensive tending and working of bamboos were continued and showed that such intensive work is economically justified by the improvement in the condition and yield of the clumps and the increased revenue obtained.

(viii) *Mixtures*—Nil.(ix) *Underplanting*.

(a) *Teak plantations*.—All plots were maintained and new plots of *Bambusa polymorpha* were established. Experience so far indicates that teak plantations can be successfully underplanted with *Bambusa arundinacea*, *Cephalostachyum pergracile* and *Hopea parviflora*. *Swietenia macrophylla* and *Cedrela toona* although established suffer a great deal from browsing and bark stripping by deer.

(b) *Evergreen rain forests*.—Experiments in the regeneration of evergreens with and without a cover crop after clear felling and burning evergreen forest have been started and show some promise. Most of the work of the past few years have been in underplanting under various degrees of canopy.

As mentioned previously, general results are :—

- (i) Top canopy cover gives the best results.
- (ii) Burning before regeneration produces no beneficial results.
- (iii) For most species transplanting is the best method and some of the tenderer species do well if mossed or basketed.
- (iv) Stump planting is not a suitable method for most evergreens. The exceptions to this are *Artocarpus hirsuta*, *Cedrela toona* and *Chickrassia tabularis*.
- (v) Weeding is worth while as it gives a slight gain in height growth and survival percentage.
- (vi) Pitting for planting is also similarly worth while although the effects of pitting do not show until the second year when the roots and their needs have both got bigger.
- (vii) The best date of transplanting for most species is mid June or early August i.e., either just before or just after the heaviest rain of the South-West monsoon.
- (viii) For most species the best size of transplant to use is from 8" to 1' high. Larger transplants occasionally do well but suffer heavy casualties and are not definitely established for several years. In the case of large transplants of *Cedrela toona* and *Swietenia macrophylla* insect attack is more serious than with small plants.

(xi) *Miscellaneous*.

Sandal Spike Disease Research.—A brief summary of results so far is :—

- (a) Spike is an insect-borne disease.

- (b) The insect or insects responsible cannot pass through a mesh of $1/20"$ but can pass through one of $1/4$ th inch.
- (c) The insect responsible operates at night and in one main season of August to November with a secondary season in April-May.

Anti-spike operations carried out continued to be successful and indicate that such control measures are fully effective in the case of areas where only a few trees are found infected and that in the case of large blocks of forest where the disease has been allowed to spread for some years uncontrolled the effect of the control operations is to confine the disease to the original limits of the outbreak.

The loss of revenue averted by the success of these control measures is already considerable.

Periodicity of height growth.—Indications are the same as recorded in last year's report. Weekly measurements showed that in deciduous forest the general rest period was from the middle of November to the middle of April. In evergreen forest and in dry fuel forest most species grow slowly but steadily all through the year.

Weeds—Lantana eradication.—Experiments in the suppression of *Lantana* by underplanting it with *Bambusa arundinacea* were extended and continue to look promising.

Large scale experiments in destroying this pest by spraying with a Sodium chlorate spray show that the method is the most successful and least expensive of any method so far tried.

Experiments on the suppression of *Eupatorium* by means of *kikiyu* grass (*Pennisetum clandestinum*) were extended and continue to look promising. This work is most important in the reclamation of grazing areas which have been invaded by the pest.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plans.

Five working plans were under preparation at the beginning of the year and 5 were completed during the year. 2 new plans were started during the year.

The cost of preparation inclusive of establishment was :—

	Per acre.
(a) Vellore East Working Plan	3·9 annas.
(b) Cuddapah South Working Plan	1·5 annas.
(c) The Nilgiris Working Plan	4·2 annas.

(ii) Yield, Volume and form factor tables.

During the year the Central Silviculturist, Dehra Dun compiled new (provisional) yield tables for Nilambur plantations. The great practical point that has arisen during the preparation of these tables is that if the number of stems per acre is plotted against "top height" (instead of against age as is usually done), the resulting curve is practically independent of quality of locality or age.

Hence it has been possible to prepare a table of top heights and the corresponding number of stems per acre that should be present.

145 sample plots representing 16 species were maintained ; 20 new sample plots at Nilambur to compare teak growth from different origins and 5 new teak sample plots in the Wynnaad division were opened.

36 Tree Increment Plots and 18 preservation plots were maintained.

III.—MISCELLANEOUS.

Tours.

The Provincial Silviculturist toured for 190 days during the year. The sandal spike disease research works in North Salem division were inspected by him and also by the Forest Botanist, Dehra Dun.

The Provincial Silviculturist was deputed to the "Research demonstration Course" held at the Forest Research Institute, Dehra Dun, in October 1937.

The Forest Botanist, Dehra Dun, visited all the four linear tree increment plots which were opened during the year, and he started the work of tree identification in all these places.

The Central Silviculturist, Dehra Dun, also visited and inspected the Research Experimental works at Chandanathode Kannoth, Nilambur, Nilgiris, Emmanuel, Walayar, Dhoni, the irrigated teak plantations at Hulical drug and the district "rab" and "kumri" works in the Ayyalur range of Madura district.

Books and Publications.

"The note on a tour in South Bengal" is about to be published soon.

The following pamphlets were written during the year by the Assistant Silviculturist and submitted to the Chief Conservator of Forests, Madras.

1. A note on the cultivation of the Green wattle (*Acacia decurrens*) in South Africa and South India.
2. A short note on *Cassia auriculata*.
3. A note on the financial aspect of planting wattle (*Acacia decurrens*) in the Nilgiris.

The results of some of the closed investigations were summarised and written up as pamphlets by the Provincial Silviculturist during the year.

They are :—

1. An investigation into the best date of stump planting teak (*Tectona grandis*) at Begur, Dhoni, and Topslip.
2. An investigation into the relative merits of planting teak (*Tectona grandis*) stumps in pits and crowbar holes in areas having a west coast type of climate.
3. An investigation into the best root lengths of stumps to use when stump planting teak (*Tectona grandis*).

All the above three investigations are being published as " Indian Forest Records " by the Forest Research Institute, Dehra Dun.

Besides the above, two sets of Research experiments on soil working in dry fuel forests (Enimanur) in Coimbatore North Division were also summarised and submitted to the Chief Conservator of Forests.

Records.

The Specific and general Ledger files now number 436 and 156 respectively.

41 new Experimental Plots and 192 new Experimental Garden experiments were opened during the year while 11 experimental plots and 151 Experimental Garden Experiments were summarised and closed. At the end of the year 106 Experimental Plots and 328 Experimental Garden experiments were open.

176 Photographs were added to the collection during the year and the total number of photographs now ledgered is 636 under specific and 320 under general ledger files.

Staff.

The Extra Assistant Conservator of Forests remained in the division throughout the year as assistant. The subordinate staff now consists of 3 Research Rangers, 9 Foresters, and 1 Forest Guard.

NORTH-WEST FRONTIER PROVINCE.

I.—*Experimental Silviculture.*

(i) *General.*

The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*), and silver fir (*Abies pindrow*) particularly in forests worked under the uniform system.

(ii). *Natural Regeneration.*

The experimental plots previously laid out to ascertain the most suitable intensity for a seeding felling in blue pine forest have given no definite results and have now been given up. In their place experimental plots have been established by the Punjab Research division to study the effect of the following factors on blue pine seedlings :—

- (a) Grazing,—normal, controlled and completely closed.
- (b) Removal of *Viburnum* weed, and method of removal by cutting it at ground level, 2' to 4' above ground, treating it with Sodium arsenite and spraying it with Sodium chlorate.
- (c) Rodent damage.
- (d) Density of overwood.
- (e) Soil working.
- (f) Different aspect and soils (shale not yet included).

Plots 1 to 4 (with 18 sub-plots) were laid out to study the factors affecting the progress of seedlings in the reestablishment (unestablished and established stages) while plot 5 (with 8 sub-plots) was designed to study the effect of (i) grazing, (ii) removal of *Viburnum* by cutting or poisoning, and (iii) exclusion of rodents on the influx of natural seedlings of blue pine.

(iii) *Seed.*

The year 1937 was a poor seed year for deodar, silver fir and chir, but was moderately good for blue pine.

(iv) *Nursery Work.*

In addition to the ordinary nurseries, maintained in the hill divisions, for re-stocking the areas felled over, a large nursery is maintained at Nowshera, and others at Cherat, Parachinar, and Malakand in the Peshawar Division, for the supply of plants required for station planting and the re-planting of canal banks. A large nursery is also maintained at Razmak for the supply of fruit and garden plants, and despite the unsettled conditions of Waziristan, no less than 15,000 plants were distributed during the year.

(v) *Artificial Regeneration.*

Cedrus deodara.—Sowings of deodar on burnt patches continue to give marvellous results in the blue pine regeneration areas in Upper Siran range. The resulting crop after the first seeding felling has every prospect of being at least 50 per cent. deodar. Surplus plants transplanted from these patches have also done well, success being 70-75 per cent.

Pinus excelsa.—In Upper Siran, blue pine seed sown broadcast during the monsoon, after soaking in water for 48 hours, has germinated well, but it remains to be seen how much will survive.

Pinus longifolia.—During the last five years *chil* plants raised in tin tubes have been successfully planted in Cherat Cantonment and Malakand Agency forests. But the subsequent development of the plants is unsatisfactory chiefly because of the unfavourable condition of the soil.

Nannorhops ritchieana.—Experiments on the propagation of this species, both by sowing in interrupted channels and planting of off-ssets without artificial irrigation, were carried out in Jarnia sample plot for three years, but without success. This year seed was sown in 100 horizontal interrupted channels in Khawara with encouraging results, as not only was germination good, but a fairly large number of seedlings are still surviving. The soil in Khhwara is rocky whereas in Jarma it was clayey from which it appears that the former is preferred by this species.

(vi) *Reclamation, etc.*

A considerable area of Upper Siran forests was burnt by a fire in the winter of 1932 and almost laid bare of existing vegetation and seed bearers. An acre of this area, open to grazing, was raked up and sown broadcast with *Indigofera* seed in April last year. The seed germinated profusely during the monsoon but the young plants were considerably damaged by grazing. The idea was to raise nurses to afford shelter to blue pine and deodar regeneration.

(vii) *Tending.*

The effect of early cleaning on deodar sown on burnt patches is shown by the following averages of measurements made in one patch. Sowings were made in December 1935 and germination took place in April 1936, so at the time of cleaning in July 1937 the plants were 15 months old :—

No. of plant.	Average height on 7-7-37.	Average height on 10-9-37.	Average height on 1-5-38.
8	1' 4"	2' 0"	2' 2"

(viii) *Miscellaneous.*

Grazing.—In the case of chir regeneration areas, where the young crop is established, the effect of increasing the grazing incidence from 8 acres to 6 acres per head of cattle continues to be beneficial. Dense

growth of *sheroo* (*Imperata spp.*) grass is kept down and chir seedlings are beginning to appear in places where they had hitherto failed.

II.—WORKING PLANS AND STATISTICS.

(i) *Working plans.*

The revision of the Galis working plan was completed. This prescribes the selection system for all forests capable of being worked for revenue, in place of the uniform system under which they were previously managed. The Inspector General of Forests visited these forests in May 1937 and on his recommendation the yield was fixed at 1·5 per cent. of the enumerated growing stock for blue pine and 1·3 per cent. for silver fir. With blue pine this is rather less than Von Mantel with a 120-year rotation, which would work out at 1·66 per cent., while with fir it is almost the same as Von Mantel with a 150-year rotation, *viz.*, 1·33 per cent. Regarding the latter percentage the Inspector General remarked that in view of the age class distribution it was probably more than should be felled; and that on the other hand much of the older stuff was deteriorating and had better be removed.

(ii) *Yield, volume and form factor tables.*

The measurement of old sample plots was carried out by the Punjab Research division,—nine sample plots in the Galis division (blue pine) and one (chir) in the Kagan division, which were due for re-measurement.

ORISSA.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

As in 1936-37, Mr. J. W. Nicholson, I.F.S., had to carry out the duties of Research Officer in addition to his duties as Conservator of Forests. It was possible to make some progress in laying out new experimental plots but, owing to pressure of administrative duties, the execution of the work had to be left mainly to the Research Forest Ranger. Mr. D. H. Khan, who was newly posted to the Province as Research and Working Plans Officer, is expected to take over the duties of Research Officer about October 1938 after he has had some preliminary training at the Forest Research Institute; and it is intended to draw up, in consultation with the Central Silviculturist, a triennial programme of silvicultural research work to commence from 1939-40.

Following upon the decision made in 1936-37 to confine research work to really important problems the previously existing experimental plots in the Ganjam division were closed down.

Out of a total of 66 experimental plots distributed over 6 divisions 30 were abandoned and 14 new plots laid out during the year, and the total number of plots at the close of the year has been 50 only.

(ii) *Natural Regeneration.*

Sal.—The most important problem is the re-obtaining of sal regeneration in the *mals* forests of Puri Division. During the year the series of experimental plots was not examined for progress. A dry cold weather enabled burning to be carried out far more efficiently than in previous years and an excellent seed year followed. Unfortunately, owing to a mistake, some plots were not burnt according to programme.

Plots previously established in Chatrapur division to investigate methods of producing sal regeneration by manipulation of the canopy were abandoned, as it was found that existing regeneration was more or less normal for the type.

In Ganjam division the six experimental plots in Rambha Reserve were abandoned. The treatment produced a profuse invasion of bamboos instead of resulting in any increase of established sal regeneration. In their place a new plot, has been laid out to test the possibility of establishing regeneration of sal and other valuable species by removing inferior species in the canopy and thereby admitting more light.

The series of 24 experimental plots in Galleri reserve laid out to trace the history of young sal regeneration were also abandoned during the year, as no reliable results could be expected. In their place 3 new plots were laid out in the Plains Sal Timber Working Circle. In one plot the crop has been left unfellled ; in the second, the crop was felled and will be cleared according to the present working plan prescriptions ; and, in the third, the crop was felled but it will be left uncleared. Two new experimental plots were laid out in a 9-year old sal forest (Plains Sal Timber Working Circle) with the object of testing the effect on sal natural regeneration of annual early burning as compared with complete protection for 4 years followed by a late fire every fifth year.

An experimental plot was laid out in Kusumjhor Coppice Felling Series, Sambalpur Division, to ascertain the effect on coppice growth of retaining standards.

In Angul division the main problem, in the old P.B.I., is to find out how best to assist sal regeneration against *Bambusa arundinacea*. Burning the clumps results in very untidy growth as well as affording good support for climbers. Clear felling the clumps gives the best

results, and efforts are now being made to get bamboo contractors to carry out clear felling where such is wanted.

Teak.—2 experimental plots were laid out in Puri division, to test the effect of early burning in teak plantations established in the dry Puri coastal type of forest. Teak regeneration in damper types is usually found only under mother trees growing in the open. Experiments to increase natural regeneration in Ankula teak plantation are said to be yielding good results.

Casuarina.—Layering experiments have not proved successful as so far only 10 per cent. of the layered branches have taken root.

Miscellaneous.—2 experimental plots were laid out in a Coppice Felling Series of Puri division, to test the effect of early burning on the regeneration of important tree species in dry evergreen thorn forest.

(iii) Seeds.

Nothing of importance to record.

(iv) Nursery Work.

The *dona* system of raising nursery seedlings was tried in several divisions. The system appears to be one worth following where stump planting is not possible (as in teak *toillas**), or where there is a shortage of stumps, and, in the case of species which do not stump well. The system can only be followed, however, where the nursery and water are near the plantation site.

In Angul division an experiment was tried to raise teak stumps in dry *rab* nurseries. The results have been most encouraging as 50 per cent. of the plants have proved fit for stumping at one year's age. With improved technique a higher percentage should be obtainable. The advantages of this system are the very low nursery costs and reduced expense in carriage of plants to the planting site.

(v) Artificial Regeneration.

Rab sowings were tried in several divisions. In Barapahar, on poor dry soil, successful results were obtained with *Adina cordifolia*, *Gmelina arborea*, *Terminalia tomentosa*, *Dalbergia latifolia*, *Lagerstroemia parviflora*, *Pterocarpus marsupium*, and *Albizia procera*, but considerable damage occurred from browsing in unsentenced plots. In the 1936 *rab* sowings *Pterocarpus marsupium* and *Dalbergia latifolia* have reached a height of 5 feet. In Sambalpur, results were less successful due, it is thought, to late sowings. In Chatrapur, teak, *Casia siamica*, *Acacia arabica* were tried, but owing to shortage of rain the results were not so

* Dry cultivation or *taungya*.

good as in 1936-37. In Puri, *rab* sowings of teak were a failure due to the use of immature seed. In Angul, *rab* sowings of teak, *Gmelina arborea* and *Ougeinia dalbergioides* gave good results on suitable soil. Experiments are being undertaken on a still larger scale in 1938-39.

Sandal sowings were done in Chatrapur and Parlakimedi divisions. It has been found necessary to revise the methods laid down in the working scheme which insisted on clean weeding and sowing of host plants. The older method under which sandal seeds were sown under bushes with existing forest trees as hosts has given far better results. Further, instead of sowing (or planting) sandal inside forest areas it has been decided to carry out sowings by forest subordinates free of cost along roads and boundary lines wherever lateral shade and suitable hosts are available.

In Puri division, *dona* planting of teak in teak plantation areas gave very good results. Experiments in line planting of teak were carried out. The original evergreen forest was felled and the teak planted in lines 24 feet apart. Where *toila* cultivation is not possible such line planting, judging from the results of old line plantations, should prove most successful.

(vi) *Reclamation and Afforestation including irrigated plantations.*

The experiments in the afforestation of dry type soils in Motijhoran reserve, Sambalpur division, were continued. Of cuttings tried *Boswellia serrata* and *Erythrina suberosa* gave the best results. 12 different species were planted out by *dona* methods. The most successful as regards survival have been *Kigelia pinnata*, *Prosopis glandulosa*, *Pterocarpus marsupium*, *Anogeissus pendula*, *Holarhena antidysenterica*, *Thespesia lampas*. *Prosopis juliflora* has been partially successful. The season was an unsavourable one, and the results achieved are as good as could have been expected. Until the plants have pulled through two hot weathers results cannot be definitely assessed. To hold up run off in this area, gullies were bounded and planted with *sabai* (*Polliniidium angustifolium*) grass.

In Barapahar division afforestation experiments were similarly carried out on dry infertile soil. Contour ridging at 4 feet vertical intervals, planting of cuttings, *dona* planting and line sowings of sal were tried. *Dona* plants of *Anogeissus pendula* and *Prosopis juliflora* did well to begin with but later suffered many casualties. *Dona* plants of *Pterocarpus marsupium* alone give any promise of success.

Experiments were continued in planting out *Dalbergia sisoo* and *Albizia procera* in abandoned paddy fields in Sangraimali reserve of Sambalpur division. *Dona* planting and one year old stumps were tried. Very poor results were obtained, attributed to a poor rainy season and subsequent drought.

65 rhizomes of *Bambusa vulgaris* were planted in the Puri *Casuarina* plantation, out of which number 54 were surviving in good condition.

Anti-erosion experiments in Chandragiri reserve, Russellkonda division, were continued. In Orissa, as well as in most other provinces in India, the problem of erosion has not received the attention it deserves. Erosion is mainly due to misuse of land by cultivators and graziers but it is also caused by faultily constructed and drained roads as in the Agency tracts, for instance. The problem is of such magnitude that it can only be tackled by an All-India Soil Conservation Service established on the lines of that in the United States of America.

(vii) *Tending.*

Useful information was obtained from the experiments on the Plains Sal Timber Working Circle in Russellkonda division in regard to cleanings in one-year old sal crops. The experiment indicates that cultural operations should be left until the end of the hot weather when it is not difficult to uproot perennial climbers as soon as the first heavy rain loosens the soil. A further experiment in reducing tending costs was tried by abandoning in one half of the previous year's coupe the costly prescription for cutting back, heaping and burning. After the rains it was found that the condition of the crop in the untreated area was as good as in the treated area, and it was, of course, more advanced.

A thinning experimental plot was laid out in a 10-year old coppice coupe of Puri division, to ascertain the effect of reduction of coppice shoots of *Xylia xylocarpa* at ages of 10 and 15 years. A similar plot was laid out in a 10-year old coppice coupe in Sambalpur division, sal being the species under treatment. In Barapahar division a similar but more complicated experiment was carried out in a 10-year old coppice coupe, *Cleistanthus collinus* being the species tested.

The revised thinning rules introduced in Sambalpur and Barapahar divisions have given very good results. Rules on similar lines were drawn up for the Coppice Working Circle of Puri division, where wholesale thinning of all species has given poor results.

Climber poisoning experiments were initiated in Raigoda, Angul division ; the results are as yet inconclusive.

(viii) *Mixtures.*

Nil.

(ix) *Underplanting.*

Underplanting of *Dendrocalamus strictus* forest with teak stumps was tried in Barapahar division in a coupe due to be coppiced

two years later. Initial results are very promising. Teak was introduced in lines 24 feet apart in certain blocks in Angul division. The plants are surviving but, due to heavy overhead shade, are not putting on satisfactory growth. Experiments under lighter shade will now be undertaken.

(x) *Silvicultural systems.*

The Palaman system of not compelling clear felling in coppice coupes was tried in Sambalpur and Russellkonda divisions. In both the market demand for small wood was sufficiently good to induce contractors to clear fell. Only in hilly inaccessible areas in Sambalpur advantage is being taken of the new system. In one coppice coupe in Russellkonda, all sal poles under 6 inches in diameter were reserved. The method is reported to have been successful.

(xi) *Miscellaneous, including fire and grazing.*

Early burning has been carried out in most Divisions. Experience so far gained is that only in very dry forests, such as those of Barapahar division, which can be burnt really early in the season, can early burning be relied upon to give good results, but in mixed bamboo forest, such as occurs in Angul division, fairly satisfactory results are obtainable. In sal forests, in Chatrapur, Russellkonda and Sambalpur divisions, the results have been bad. It is by no means certain whether early burning can ever be successfully prescribed for sal forests, other than damp coastal types.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

The marking rules for the Selection Working Circle, Angul division, were provisionally amended. The coppice with standard system was experimentally introduced in certain forests of this division in place of the selection system prescribed. It has been found that under the selection system the local demand for poles is not being met.

Certain minor amendments to the Puri Reserved Forest Plan were made.

(ii) *Yield; Volume and Form Factor Tables.*

Out of 109 sample plots distributed over five divisions, 3 were abandoned while 2 new ones added during the year. The total number of sample plots at the close of the year was, therefore, 108.

During the year full measurements were carried out in 10 and interim measurements in 1 Sample Plot.

In order to ascertain what rotation will give the highest mean annual increment, volume data were collected over 2-acre Plots in 12, 16, 20 and 24 year old poor thorn type coppice crops in three felling series in Puri division. The results have proved inconclusive owing to differences in topography and soil.

(iii) *Miscellaneous.*

Phenological data were collected for sal and teak in three divisions.

(iv) *Forest Entomology.*

Samples of insect attacked young *asan* (*Terminalia tomentosa*) plants, raised in *rab* sowings in Barapahar division, were sent to the Forest Entomologist, Dehra Dun, for identification and suggestion of remedial measures.

PUNJAB.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

(a) *Propagation of Prosopis juliflora.*—Pods were collected from known parent trees of different forms at Lahore and distributed to divisions and other Government departments. The total collection was 21 maunds, Mexican form 11 maunds, Australian 9 maunds, and the balance of Arid, Peruvian and Argentine forms. Four maunds of Australian form pods were supplied to the Agricultural Chemist, Lyallpur, for carrying out cattle digestibility tests as chemical analysis of the pods revealed that they were far richer in protein contents than common hay and possessed high nutritive value.

12,000 pot plants (Mexican and Peruvian forms) were raised at Lahore and planted over selected mile lengths along the railway line, close to gang huts, and in station yards in various railway sections.

(b) *Treatment of railway embankment at Jhelum.* The work was extended during the year taking up the entire northern face of the embankment. Nearly 1,500'×32' sloping embankment was revetted, wattled and planted with 16,000 *Agaves* and 13,000 *Ipomoea carnea* cuttings. The plants have mostly established themselves and the embankment has withstood the last monsoon and winter rains.

(c) *Distribution of ornamental plants.*—With a view to encourage tree planting a large stock of ornamental plants was raised in research

nurseries at Lahore and Chichawatni and supplied to various Government departments and public bodies at a nominal cost.

(ii) *Natural regeneration.*

With the exception of fir zone natural regeneration was generally adequate in the coniferous forests. In scrub areas reproduction from coppice shoots was satisfactory but from seed poor. In irrigated plantations there was no trouble with the reproduction of *shisham* and mulberry in coppice areas. Observations on important species are recorded below :—

Cedrus deodara.—In the dry zone natural regeneration was commonly observed under the protective shade of the mother trees. Stocking of regeneration areas presented great difficulty unless the fellings were regulated so as to afford protection from hot sun to the germinated seedlings (Upper Bashahr).

Pinus excelsa.—Natural regeneration was abundant in regeneration areas and fire blisks inspite of grazing. In fact *kail* was aggressive in most of P. B. I areas and had to be cut in favour of deodar (Sernj, Upper Bashahr). Observations in research plots in high level *kail* forests as well as in mixed *kail* and fir forests showed distinct improvement in natural regeneration where humus was scraped off or burnt.

Abies pindrow and *Picea morinda*.—Assessments of Kulu plots (Research) confirmed the previous years' observations with regard to both the effect of soil treatment and manipulation of canopy, viz., the removal of humus and exposure of mineral soil gave significantly better results ; and the influx of regeneration was inversely proportional to the opening of canopy. Under strip fellings seedlings were more numerous in 50' and 75' strips compared with 100' wide strips and under shelterwood reproduction was distinctly better in 20'×30' gaps than bigger openings of 40'×50' or 60'×70' (Research). Natural regeneration was also observed in Chak ban Kareri where humus layer was thin about 2" deep (Kangra).

Dalbergia sissoo.—Profuse natural regeneration appeared in *shisham* bearing riverain *bela*s (grassy blisks) during the summer rains but failed to survive even with effective closure. Heavy shade of mother trees, root competition of rank vegetation and prolonged submergence under water were considered to be adverse factors (Depot West). Inducing root suckers by digging trenches up to a distance of 1 chain from mother trees proved useful for stocking blisks in Ludhiana reserve (Upper Bashahr).

Morus alba.—Abundant natural regeneration of mulberry was observed annually in riverain areas under open *shisham* crops but it failed

to develop. Grazing and browsing (including *nilgais*) were believed to be mainly responsible for its destruction. Consequently some areas are being fenced to compare results (Depot West).

Acacia arabica.—Natural regeneration came up in abundance in riverain areas but was killed outright by frost in the open and survived only in small gaps protected by mother trees (Depot West).

Acacia farnesiana.—There has been fair reproduction in riverain areas both from seed and coppice inspite of grazing,—often growing in thickets in blanks to the exclusion of other species (Depot West).

(iii) Investigation on seeds.

(a) *Seed years*.—It was a poor seed year for deodar (*Cedrus deodara*) chil (*Pinus longifolia*) and phulai (*Acacia modesta*). The seed crop of kail (*Pinus excelsa*), spruce (*Picea morinda*), silver fir (*Abies pindrow*), and olive (*Olea cuspidata*) were moderate, and that of shisham, mulberry, bhan (*Populus euphratica*) and kikar (*Acacia arabica*) plentiful.

(b) *Seed storage*.—Storing *Prosopis* pods in tins with sand layer spread on top failed to prevent the attack of *Caryoborus gonagra*. *Salvadora persica* seed was found to lose germinative capacity on storage for one year and *Ulmus laevigata* seed after 6 months (Research).

(c) *Germination tests*.—Observations on the germinative capacity of seeds and duration of germination were recorded for all species tried in research nurseries.

(iv) Investigation on seedlings.

(a) *Seasonal height growth*.—Measurements of height growth were recorded in research nurseries. At Chichawatni (irrigated plantation) the incidence of maximum monthly increment was in July-August and growing season from March to middle of November for majority of species but some behaved exceptionally. *Casuarina cunninghamiana* and *lepidophloia* continued height growth all the year round, *Acacia farnesiana* and *Rhus lancea* started growing early in February and continued till the end of November whereas *Prosopis juliflora* (Argentina) and *Schinus molle* attained maximum growth in September last of all.

(b) *Frost injury*.—At Chichawatni the lowest temperature recorded was 26°F. Amongst the new species tried *Cassia auriculata* and *C. javanica* were entirely frozen. *Acacia caffra* and *Tipuana speciosa* also got badly bitten although they did not suffer much during previous years.

(v) *Investigations on trees and crops.*

(a) *Phenological study.*—Observations were recorded for select species (Research).

(b) *Water requirements of Prosopis.*—A plot was laid out in Arafwala plantation to study the minimum water requirements of *Prosopis* in irrigated plantations, particularly to find out if the species could do without irrigation in the months of May-June when water supply was short in plantations (Research).

(c) *Inheritance of characters.*—In the *shisham* inheritance of stem characters (crooked, forked and straight) plots, the progeny of crooked trees was observed to be weak in comparison with the other two forms.

* (vi) *Artificial regeneration.*

Cedrus deodara.—Patch sowings, done over 17 acres, were doing well (Seraj). 87,422 plants, mostly deodar, were transplanted in regeneration areas and fire blanks (Kulu).

Dalbergia sissoo.—Stocking of riverain *belas** with *shisham* in conjunction with agricultural crops was undertaken in Depot West Division, and an area of 20 acres was successfully handled. It was found easier to stock sandy loam soils than stiff clay. Stump planting gave better results than sowing. Planting in February-March proved more successful than in July-August but it was only possible where irrigation could be done in the ensuing hot weather (Depot West).

Eucalyptus rostrata.—8,801 plants were planted in the regeneration area, Changa Manga plantation, for future standards. No special irrigation or weeding treatment was given but the area was fenced with barbed wire to protect against damage by *nilgai*. Success was 34 per cent. (Tramways).

Morus alba and *Melia azedarach*.—Underplanting in *shisham* irrigated plantations was very successful (Montgomery, Multan, Research). Over 1,400,000 plants were under and interplanted during the year (Multan).

Other species.—A large number of species were tried both in hills and plains to meet various requirements. To mention a few *Thuja plicata* maintained its success in fir areas (Research). *Cryptomeria japonica* and *Cupressus torulosa* did well in Dharamsala oak forests (Kangra) and *Prosopis glandulosa* proved useful for stocking dry rakhis (Depot West), *kallar*, *rappar* and *khappar*† areas in plantations (Montgomery,

NOTE.—* *Bela* is an island in a river and thus naturally subject to submergence under water for part of the year.

† *Kallar* is loose saline soil characterised by salt efflorescence on the surface
Khappar is saline soil but harder.

Rappar is also saline but very hard and has a shining (silvery) surface.

Multan). *Prosopis juliflora* (Argentine form) did well in poor soil in irrigated plantations and together with Arid and Mexican forms in dry foothill scrub areas. Agares were found highly useful for erosion control (Research).

(vii) *Nursery work.*

Research division nurseries were maintained at Manali, Chichawatni and Sambalpani where culture of exotic and indigenous species likely to be of value for silvicultural, afforestation or counter-erosion purposes was studied and stock raised for research planting and distribution. Besides, big nurseries, both permanent and temporary, were maintained by territorial divisions for local use and to supplement research on important species of local interest.

At Khanewal (Multan) raising mulberry continuously for 3 years over the same area without manuring was noticed to impoverish the soil. The stock showed a fall in quality. In riverain tracts (Depot West) sandy loam soil was found to be best for raising shisham stock to obtain stumps. Where irrigation could be arranged seed was sown in February-March as with rains sowings much of the growing season was lost and a greater percentage of stock did not become big enough to produce cuttings for use in the following year.

(viii) *Reclamation and Afforestation.*

Research and demonstration of erosion control work was concentrated in the experimental plot at Nurpur where various species of trees, shrubs, creepers, succulents and grasses notable for quick establishment, fast growth and soil binding qualities were under trial. The plot also furnished demonstration of the methods of gully plugging and afforestation of eroded slopes as well as the value of closure in restoring natural plant cover. After 3 years of closure the growth of grass had tremendously improved and several indigenous plants, e.g., *Dalbergia sissoo*, *Acacia catchu*, *Zizyphus*, *Cassia fistula*, *Dodonaea viscosa*, *Holoptelea*, etc., had made appearance and were gradually covering the ground. Erosion trays were also installed in this plot and the data collected during the year show that run-off and soil losses were several times more from bare ground than from areas under grass and bushes (Research).

Other afforestation and reclamation works carried out during the year include the construction of 93 stone bunds (22,825 o.ft.) in Surla and Bakshiwala forests (Jhelum); gully plugging with brushwood dams in Pabbi (Lahore); the digging of 2,200 contour trenches in Kalachitta forest (Rawalpindi West and Research); the stocking of fire blanks in Nagni and Niangarh with 8,000 deodar plants (Kulu); the planting

of 'dab' grass (*Eragrostis-cynosuroides*) areas in irrigated plantations with *bakain* (*Melia azedarach*) (Multan, Montgomery) and successful stocking with *Prosopis* of *kallar* and *khappar* areas in plantations (Multan, Montgomery), of Pabbi ravine land (Lahore), dry *rakh* (plains scrub) Dhul (Depot West) and arid scrub areas in Kalachitta (Research and Rawalpindi West).

(ix) *Tending.*

Experiments were laid out (a) to study the effect of heavy cleaning in deodar crops leaving young plants 9' apart (Lower Bashahr), (b) to find out the best thinning espacement for young *chil* pole crops to reduce cost on unsaleable early thinnings, and (c) to determine the suitable intensity of second thinning in irrigated plantations (Research).

(x) *Mixtures.*

To avoid the necessity of early unsaleable thinnings and as a measure of fire-protection experimental interplanting of deodar with broad-leaved species was started in Lower Bashahr. An area of 25 acres was planted with deodar and poplars in alternate patches.

(xi) *Underplanting.*

2,789 acres were under and interplanted with mulberry and *Melia azedarach* (Multan). Experimental underplanting of *shisham* crops with *Celtis eriocarpa* in Chichawatni irrigated plantation was attended with 77 per cent. success. The plants attained a height of about 5' in 3 years (Research).

(xii) *Silvicultural systems.*

Clearfelling in winter followed by trenching in spring proved to be the best method for naturally regenerating *shisham* high forests in riverain areas (Depot West).

(xiii) *Miscellaneous experiments.*

Bhabar grass (*Ischaemum angustifolium*).—Experiments in progress in Kalesar reserve indicated that yield could be appreciably increased by planting grass tufts after heavily opening the canopy leaving about 5-7 trees per acre. Weeding promoted the spread of grass but the gain was not commensurate with the cost (Simla).

Record of ground flora in chil and kail forests.—Study is in progress on the succession of vegetation in fire blanks in *kail* forests (Lower Bashahr) and on the effect of departmental burning on ground flora in *chil* forests (Research).

II.—WORKING PLANS AND STATISTICS.

Working plans.—The position with regard to new plans is as under :—

Working plans published for :—

- (i) Simla Municipal Forests ; and
- (ii) Pabbar Valley Forests, Lower Bashahr.

Working plans in press, for :—

- (i) Changa Manga plantation ;
- (ii) Daphar plantation ; and
- (iii) Throach State Forests.

Working plans and schemes under preparation, for :—

- (i) the riverain *belas* on the Chenab and Jhelum rivers ; and
- (ii) Forests of Rawalpindi East division.

Sample plots.—Sets of properly replicated comparative thinning plots were laid out in young *chil* crops at Panjar and in *shisham* crops at Chichawatni. 57 plots were remeasured, of which the 9 *shisham* plots in Lahore and Montgomery divisions were clearfelled and fully measured. Datum boards containing crop data figures at successive measurements were posted in all the sample plots in Rawalpindi East and West divisions.

Preservation plots.—There are 44 on the provincial list covering the main forest types in the Province. One plot was added during the year.

Shisham espacement plots.—Planting espacement experiment initiated at Chichawatni in 1928 was closed during the year. Results indicated that closer espacement i.e., 5'×10' and 6'×10' gave higher outturn than 8'×10' or 10'×10' planting, besides being useful in controlling weed growth.

Single tree data.—Summary results of data collected in the course of sample plot measurements and compiled at Dehra Dun were posted in Form 10. Hill divisions also contributed in the collection of data for standard volume and commercial outturn from their felling coupes.

Miscellaneous.

Rainfall data.—Rainfall statistics collected in the territorial divisions were maintained and a consolidated annual statement prepared (Research). A rain gauge was installed at Bashla (Lower Bashahr).

Photo collection.—A substantial addition was made during the year. The collection as it stood at the end of the year was 1,608 negatives, 2,393 prints and 343 lantern slides (Research).

Records.—Two specific and seven general files were opened. The total number now stands at 156 specific and 334 general files (Research).

Library.—153 new publications were added over and above serial bulletins and periodic literature on forestry subjects (Research).

Exhibition.—With a view to educate the public on forest matters a forestry pavilion was opened in the All-India Exhibition of Arts and Industries held at Lahore in December 1937. Exhibits included erosion, forest working and Punjab forest type models and various forest products which could form the basis for the development of cottage or large scale industries. Over 3 lakhs of people visited the pavilion in the course of two months and many of them displayed a keen interest in the development of forest industries (Research).

Museum.—Steps were taken to enlarge and bring up to date the forestry section in Lahore Museum. Forestry models after display in the exhibition were also transferred to the museum. Work in the museum was in progress at the close of the year (Research).

Erosion propaganda.—Since erosion constitutes a problem of great magnitude in the Province a special forest ranger was attached to the Commissioner, Rural Reconstruction, Punjab, to enlighten the public as to its causes and evil effects by displaying erosion models and delivering lantern lectures. Beside eight talks on erosion and forest conservancy were broadcast from the Lahore Radio Station (Research).

Staff.—Dr. R. M. Gorrie was incharge of the division for 10 months and Mr. I. D. Mahendru for 2 months. For the rest of the year Mr. Mahendru remained attached to the division working as general assistant. Mr. R. S. Chopra remained attached to the division incharge of sample plot measurements and research work at Chichawatni and Sambalpani.

Bh. Gurbachan Singh, Forest Ranger, was incharge of works in Kulu and Mehta Gurdas Mohan, Forest Ranger, of works in Nurpur and Lahore. L. Chaman Lal, Forest Ranger, was attached to the Rural Reconstruction department for erosion propaganda and miscellaneous duties at headquarters.

UNITED PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

In order to review the whole range of experiments the research programme was extended for another year before drawing up a new

programme. Accordingly fifteen old experiments were closed down, three transferred to the list of preservation plots and forty were being actively maintained at the end of the year compared with fifty-eight at the close of the previous year.

The most important experiments deal with the natural regeneration of sal. Research and experimental work on this will continue for some years to be of the greatest importance.

(ii) *Natural Regeneration.*

(a) From Seed.

2. *Shorea robusta* (*sal*).—A considerable amount has already been written concerning the development of whippy shoots and woody plants when given adequate overhead light and protection from damage by browsing and weed competition. It seems to serve no useful purpose to say much more about this now. Experiments in hand will continue and conclusions can be drawn when the experiments are closed and finally written up.

The natural regeneration experiments in Haldwani, Ramnagar, Pilibhit and North Kheri continue. The most important work has been the felling carried out over regeneration in Haldwani experiment No. 18. Parts of both the originally heavily felled and the moderately felled areas have been finally felled over. For the purpose of comparison regarding the development of the sal regeneration, of the grass and weeds and of the extent and cost of subsequent rains shrub cutting, only half the overwood was felled. In both the clearfelled and half felled areas comparable plots were laid out to test the value of lopping before felling. The routine measurements of indicator lines and of clear-weeded plots, burning, shrub-cutting and weeding were carried out according to plan.

The value of intensive rains shrub cutting and grass cutting where it interferes with young sal regeneration is illustrated not only by the success obtained when it has been properly done, but also by the distinct lack of progress in an experiment (Pilibhit experiment No. 5) where it had been neglected. It is also interesting to note that rains shrub-cutting is being successfully adopted on a fairly large scale in regeneration areas in the Haldwani, Ramnagar, and Tarai and Bhabar Estates forest divisions, and where seedling regeneration exists this is undoubtedly the best way to get it up.

The study of individual seedlings in the large fenced experiments to which reference was made last year was found to be impractical and has been discontinued.

3. Where regeneration has still to be obtained, the exact method to be adopted cannot yet be laid down. But the progress towards regeneration in some plots of Haldwani and Ramnagar experiments, where regeneration was initially either scanty or absent, has of late been very encouraging to indicate that the experimental work is on correct lines towards the solution of the problem. No success has so far been obtained in obtaining and establishing regeneration in damp evergreen areas. The question of obtaining and establishing sal regeneration *de novo* continues to be the most important item in our programme.

(b) From Coppice.

4. *Acacia arabica* (*babul*).—The *babul* coppice experiment has now been closed. In spite of a mild frost and good rains last year, high mortality continued. Climatic and soil conditions, coupled with animal damage, in the Etawah ravines are such that *babul* coppice growth cannot succeed.

5. Hill oaks.—*Quercus incana* (*banj*).—The coppice at Bhowali continues to do well. It was freed from suppression by natural *Pinus longifolia* (*chir*), which had come in abundantly following protection from fire and grazing. The *Quercus dilatata* (*tilonj*) and *banj* coppice near Kilberry has developed poorly, chiefly owing to browsing and weed competition, and the experiment has now been closed. The *Quercus lanuginosa* (*rianj*) coppice plot has been constituted as a sample plot.

6. *Acacia catechu* (*khair*).—It was noticed in the Tarai and Bhabar Estates forest division that *khair* trees (even large ones over 16" diameter at breast height) produce coppice shoots if the roots were wounded below ground level after felling. Protection from browsing is necessary.

(iii) Seed supply.

7. The United Provinces seed store at Clutterbuckganj continued to collect, distribute and arrange for seed for indentors both within the United Provinces and outside. *Acacia catechu* (*khair*) seed predominated (39½ mds.), with Burma teak seed next (32 mds. 3 seers), together with cleaned mulberry seed (19 mds.), *Dalbergia sissoo* (*sissu*) (15 mds. 35 seers), Bamboo (1 md. 35 seers) and others.

As usual, germination tests of various species were continued at Clutterbuckganj. It is proposed to publish the analysis of results obtained to date in the form of a bulletin or leaflet.

(iv) Nursery work.

8. The Clutterbuckganj and Haldwani nurseries were maintained for plantation supply, germination tests and preliminary small scale

experiments. Great success has followed the sowing of South African grass seeds (*Digitaria scriata* and *Digitaria pruriens*) in the Clutterbuck-ganj nursery, and the grasses are being further propagated to raise stock for large scale sowings and plantings in the *taungya* area. Root stocks of various South African grasses, however, have not developed well.

Pinus caribaea seedlings continued to persist although there was considerable mortality probably due to excessive watering.

(v) Artificial Regeneration.

9. *Acacia catechu* (*khair*).—It has been definitely shown in the Tarai and Bhabar Estates forest division that *khair* cannot be successfully raised without rains, weedings.

10. *Polliniellum angustifolium* (*bah* or *sabri*).—The Ujhani experiment on sandy soil has now been closed as the soil and climatic conditions (frost and drought) proved inimical to the growth. The *bah* plots were, however, quite successful, producing a yield of $21\frac{1}{2}$ mds. per acre, although the spacing was $3' \times 3'$, which has elsewhere been found to be too wide a spacing.

11. In the South Kheri and Pilibhit divisions of the Eastern circle the *bah* plantations continue to be very successful except in the latter division on unsuitable areas. Some plots in South Kheri have produced as much as 58 mds. per acre. The experiment to determine the optimum spacing continues. Indications at present go to show that best results are produced with a spacing of $2' \times 2'$.

12. *Tectona grandis* (*teak*).—There was no frost damage during the year in the all-India teak seed origin experiments. The Haldwani plots were thinned just after the close of the year and the question of laying out sample plots will be considered next year.

13. *Santalum album* (*sandal*).—Cuttings made from *sandal* thinned out of old clumps were placed four each round fresh *Lantara* clumps. They have mostly sprouted and developed well. Cuttings put out round bamboo clumps in the Haldwani nursery have mostly not developed, due apparently to excessive shade.

In Jhansi there was a fair recruitment of *sandal* seedlings. Six seedlings of the year grown with host plants in bamboo pots were planted out, but the seedlings died.

14. Artificial regeneration on a large scale continues to be a routine measure in many divisions both with and without *taungya*.

(vi) Reclamation and Afforestation.

15. *Usar*.—The Makdumpur experiment was kept closed to grazing during the year. The yield of dry grass averaged $13\frac{1}{2}$ maunds per acre,

the best plot yielded 21 maunds per acre. A scheme has been prepared to reorganize this experiment, laying out a new one along side, and allowing controlled grazing in both. The present experiment will then shew what incidence of grazing a protected *usar* area can stand without deterioration, and the new one what incidence, compatible with improvement, can be allowed *ab initio*.

16. *Bhur*.—Provided the sand grains, which chiefly compose a *bhur* soil, are fine rather than coarse in texture successful afforestation depends more on climatic conditions than on the soil itself. In the Ujhani and Faridpur experiments both frost and drought have prevented the successful development of all the tree species tried. In such areas in the plains *Pollinidium angustifolium* (*baib*) is the only thing with which any real success has been achieved.

(vii) *Tending*.

17. In the Dehra Dun division there are some thousands of acres of sal sapling crops mostly the result of cutting back advance growth. Sets of comparative thinning plots with three different intensities were laid out by the Central Silviculturist, to study the optimum intensity for thinning such crops.

(viii) *Mixtures*.

18. The question of mixtures in the Saharanpur *taungyas* continues to receive attention. It has been found that species that are readily browsed are considerably damaged when the cultivators leave the area. Mixtures of such species with others that are thorny or are not readily browsed are being tried.

(ix) *Underplanting*.

19. A number of underplanting experiments have been in progress in the Clutterbuckganj *taungya* area. These have shown that mulberry develops best when there is not too much overhead shade; it has done well under *Dalbergia sissoo* (*sissu*) and open *Acacia catechu* (*khair*), but poorly under heavier *Acacia catechu* (*khair*) shade. Both sowings and cuttings of various sizes have developed well. *Eugenia jambolana* (*Jaman*), on the other hand, has done poorly wherever tried in open areas, but has developed well under heavy *khair* shade. *Holoptelia integrifolia* (*kanju*) which did poorly under light *Acacia catechu* (*khair*) and was subsequently replaced by mulberry, has developed well now that the *khair* canopy has closed up, and is suppressing the mulberry put out to replace it.

(x) *Silvicultural Systems.*

20. Nothing special to report.

(xi) *Miscellaneous.*

21. In the resin tapping experiment at Garkhet in Almora a fresh series of channels was begun. These channels will be tapped for a second year then the experiment will be closed and written up.

The propagation of *Saussurca lappa* (*kuth*) at 6,000' near Garkhet was practically a failure. Germination was good but mortality due to drought considerable.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

22. Working plans for the Naini Tal and Saharanpur forest divisions and for the Muktesar Institute and Ranikhet Cantonment forests were completed during the year. Working plans were in preparation for the Lansdowne, South Kheri and Garhwal forest divisions and the Lansdowne Cantonment forests. Preliminary working plan reports were written for the Garhwal and Dehra Dun forest divisions and the Naini Tal Municipal forests.

(ii) *Yield Tables.*

23. Eighty permanent sample plots were re-measured in the Chakrata, Ramnagar, Kalagarh and Silviculture divisions. Owing to the unexpected transfer of the Assistant Silviculturist some sample plots in Lansdowne division could not be remeasured. The first remeasurements of the linear sample plots in Ramnagar and Kalagarh divisions were done this year, and the data have now to be statistically analysed.

(iv) *Miscellaneous.*

25. Bulletin No. 10 "The Taungyas of the Saharanpur Forest Division" was issued during the year.

Over 500 photographs, received from the Central Silviculturist, were added to the Provincial collection.

26. The Silviculturist gave ten lantern lectures (besides several informal lantern shows) to different schools and colleges in some important places of the province. He was appointed secretary of the United Provinces Standing Fodder and Grazing Committee.

27. The staff employed on silvicultural and statistical research work consisted of the Silviculturist, the Assistant Silviculturist (for part of the year), one forest ranger, one deputy ranger and three foresters.

CHAPTER III.

FOREST BOTANY.

ASSAM.

I.—OECOLOGY.

During the year under review little progress could be made in the collection of specimens from the *Sal* Forests of Goalpara for the detailed study of the different kinds of vegetation and its ecological association. This is a matter which must await better times. As mentioned by Dr. Bor, in the last report, it is hoped that the officer-in-charge of the revision of Goalpara and Kamrup Working Plans will be in a more convenient position to be able to collect data for this very important work.

The botanical investigation in the newly explored forest tract opened up with the construction of the Sylhet-Shillong road was continued and the specimens collected were separately stocked for examination in order to find out the important species.

Dr. Bor who was keenly interested in the relict forest of the Khasi and Jaintia Hills (*vide* last report) made an intensive collection of plants of the Shillong Plateau in order to determine what was the actual climax forest of these hills above 4,000 ft. His publication on the subject is being awaited with much interest.

II.—SYSTEMATIC.

Herbarium work and other investigations.

The new *Eugenia* found in the Sadiya Frontier Tract by Mr. Purkayastha has been named *Eugenia assamica* Bis. et Purk.

The description of a new species of *Phœbe* which has been published in the "Science and Culture" as "*Phœbe assamica*" Kalyan Kumar is reported to occur in the Sadiya Frontier District. Enquiries are being made regarding the availability of the type sheet of the species for reference and collection of materials for herbarium record.

The herbarium has been maintained in good condition. Marked progress has been made in mounting specimens. About 5,000 sheets have been properly mounted and 4,000 specimens have been added and laid into the herbarium. Very little touring for collection outside

the nearer areas in the Khasi and Jaintia Hills was possible for want of requisite staff and for funds. Activities had been chiefly confined to areas in and about head quarters and have been directed to keeping the permanent collections in a proper state of preservation and storage, to deal with material already accumulated and awaiting attention, answering the various references that are normally directed to the Department and to push on the publication of Volume II of the Assam Flora.

Throughout the year ungrudging assistance was rendered by the staffs of the Royal Botanic Garden, Kew and of Sibpur and the Forest Botanist, Dehra Dun in many directions for which they deserve our best thanks.

A fair amount of identification work was carried out locally for the herbarium and for Divisional Forest Officers. The work of poisoning the collections was also continued as far as practicable by the existing staff.

Duplicate herbarium sheets were received as follows :—

Forest Research Institute, Dehra Dun 5 sheets.

Forest Research Institute, Fed. Malay States 24 sheets.

Royal Botanic Garden, Sibpur 1 sheet.

Duplicate Herbarium sheets were supplied as follows :—

Forest Research Institute, Dehra Dun 12 sheets.

Royal Botanic Garden, Kew 7 sheets.

Dr. E. K. Janaki Ammal, Genetist, Imperial Sugarcane Station, Coimbatore 3 sheets.

Royal Botanic Garden, Sibpur 12 sheets.

Conservator of Forests, Forest Research Institute, Kopong, Solangar, Fed. Malay States Complete fruiting material of *Shorea assamica*.

The following herbarium materials were lent to other persons and institutions, etc. :—

Health exhibition stall, Shillong 44 specimens of indigenous medical plants of Assam were exhibited with details recorded thereon for the Health Exhibition held at Shillong from 1st to 5th April 1938.

Seeds of the following species were received as follows :—

Pinus longifolia }
" *excelsa* } Silviculturist, U. P.

Eucalyptus globulus (blue gum) Silviculturist, Madras.

Derris elliptica State Agricultural Officer, Solangar, Fed. Malay States.

Seeds or roots, etc., of the following species were supplied as follows :—

<i>Shorea assamica</i> (seeds)	Conservator of Forests, F. R. I. Fed. Malay States.
<i>Morinda umbellata</i> (root)	Dr. R. Pfistor, Guimet museum, Paris.
<i>Evodia roxburghiana</i> (root bark)	Forest Botanist, Forest Research Institute, Dehra Dun.

Exchange relations were continued with the following and publications and herbarium materials were received and distributed mutually :—

- (1) Prof. S. P. Agharkar, Head of the Botany Department, University College of Science, Calcutta.
- (2) Director of Gardens, Straits Settlement, Singapore.
- (3) Forest Botanist, Forest Research Institute, Kepong, Selengar, Fed. Malay States.
- (4) Prof. T. Tanaka of the Imperial University Taihoku, Formusa, Japan.

Various enquiries of scientific and economic importance were dealt with by this herbarium through the Conservator, Divisional Forest Officers, Institutions and other concerns in and outside India.

The herbarium continues amply to justify its existence locally and also to scientific Institutions in India and in other parts of the world. It is being more usefully used by the Forest Utilisation Officer, Assam, than anybody else for information in connection with development of the trade in various articles of minor forest produce. An account of the herbarium was supplied in connection with the last session of the Science Congress held in Calcutta in January 1938 for its inclusion in the account of the discussion on a National herbarium.

Staff.

The post of the Botanical Forest Officer was held by Dr. N. L. Bor, Deputy Conservator of Forests, till the afternoon of 10th October 1937 when Mr. R. N. De, Deputy Conservator of Forests took over and held the charge for the remaining period of the year.

All the members of the staff worked well during the year. It is a pity that they have been in the temporary establishment for a very long period although the proposal for their confirmation was accepted by the Government in 1935 and was passed by the Council in 1936. In the best interest of the Department and the public alike, the permanency of the staff is urgently called for. Loyal and honest work cannot be expected from a discontented staff for long.

III.—PATHOLOGY.

The attack of a *fungus* is exceedingly common in the Short-round pine forests of Shillong manifesting itself in a cankerous or tumour-like

growth on the stem or the branch. In the ecidial stage, yellow pustule-like fruiting bodies appear on the bark covering the tumour. A specimen of the fungus has been sent to the Forest Research Institute, Dehra Dun, for examination.

Sissu (Dalbergia Sissoo) seedlings in the Nonoi plantation of the Darrang Division were suspected to have been attacked by a fungus and the Botanical Forest Officer collected some specimens, which were sent to Dehra Dun, for examination. It transpired that some of the young terminal shoots were attacked with fungus with fructification of a *Phoma* sp. which causes wilting followed by death to the affected parts.

IV.—PUBLICATIONS.

Volume II of the "Flora of Assam" and Assam Forest Records, Volume II (Botany) edited by Mr. A. Das, I.F.S. (Retired) consisting of several species of *Phæbe* and the 4 new species mentioned in the last report were published during the year.

Collection of materials for the revision of the list of known poisonou^s plants of Assam was continued.

A list of indigenous medicinal plants of Assam was drawn up for the herbarium exhibits displayed in the Shillong Health Exhibition held in March 1938.

Revision of the manuscript of Volume III of "Flora of Assam" (*Gamopetalae*) was practically completed and made ready for the press.

BENGAL.

Collection of specimens of doubtful or unknown plants was continued and sent to the Forest Botanist, Forest Research Institute, Dehra Dun, for identification. Herbarium specimens of *Betula* species from Kalimpong Division, were sent to Dr. J. M. Cowan, I.F.S. (Retired), Royal Botanic Garden, Edinburgh.

Forest Mycology.

Dr. K. D. Bagchee, Mycologist, from the Forest Research Institute, Dehra Dun, visited Buxa Division, in conuection with his investigation of the fungi attacking *sal* trees and specimens were collected and sent to Dehra Dun in this connection.

BIHAR.

I.—ECOLOGY.

Soil moisture Tests.

Irrigated Vs. Un-irrigated land, Nankum.—Through the courtesy of the Director, Lac Research Institute, and with the active co-opera-

tion of the Entomologist, soil samples were taken on 25th April 1938, at 1', 3' and 6' levels on ordinary and contour trenched land in the Namkurn Lac Orchard near Ranchi. The moisture percentages were worked out in the Institute's laboratories.

The orchard 85 acres in extent, faces West with trees 12'-20' apart according to species, on gently sloping land with practically only one gradient and with canopy at present incomplete especially after pruning takes place. The soil, a deep loam, is admirably suited for soil moisture tests. The two areas as far as could be observed were strictly comparable. The general appearance of the lac host trees was better on the unirrigated plot than on the irrigated area.

The 9 acre irrigated area was laid out with contour trenches 2' or more deep by 2' wide at 35 yard intervals down the four hundred yard slope at the beginning of the previous monsoon. The trenches were sufficiently deep and sufficiently close to each other to ensure that every drop of the monsoon rain water was held up, except at the bottom where the slope eased off and clay was met with, at the 3' level. Here water overflowed the trench. The tests were taken at the driest and hottest time of the year after a severe dry April. No rain had fallen for at least six weeks. No. 1 soil pit was dug at the top of the slope between the 1st and 2nd trenches, No. 2 midway down the slope and No. 3 at the bottom just below the last trench. Nos. 4, 5 and 6 pits on the non-irrigated areas are comparable in situation to Nos. 1, 2 and 3 pits respectively.

Both the irrigated and the non-irrigated areas had a grass cover which helped to prevent evaporation, though this cover was only one year old and not fully complete.

Soil moisture percentages are of little value, unless, they can be interpreted in terms of the growth yields which may be expected. No growth yields are available for tree species for different percentages of soil moisture, as the difficulties which surround such an experiment are well nigh insuperable except perhaps for very small trees, but growth yields for barley (and for wheat at a later date), were worked out as long ago as 1883 by Hellriegel (Russell's Soil Conditions and Plant Growth) on sand pot cultures. As plant growth under semi arid conditions is largely determined by and almost proportional to the amount of water available in the soil up to 60 per cent. of saturation (Russell), these yields have been used to indicate the extra amount of growth which one might possibly obtain from the extra moisture available in the irrigated area.

The results are given in brief in tabular form:—

*Examination of small varicose red cinnabary in the posterior part of the Nervous Line Ocreans: prof. Dr. J. P. S. Lederer
on 27th May, 1938.*

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Unfortunately some of the samples contain stones which preclude their comparison with their corresponding opposite numbers. Thus none of the 6' level samples can be compared nor can the 3' levels in pits Nos. 5 and 2.

The first thing to notice is that all the irrigated samples without exception show higher moisture values than the un-irrigated ones.

Secondly, that for the five samples which are comparable, the predicted increase in growth is significant, ranging from a 26 per cent. minimum to a 200 per cent. maximum, this in the driest time of the year, when growth in trees begins. Khair (*Acacia catechu*), palas (*Butea frondosa*), and ber (*Zizyphus jujuba*) are all pruned in the period March-May for the July or the October-November infection of the new young shoots, so that the value of the extra stimulus to growth which contour irrigation gives to these new shoots can be appreciated—the bigger and more succulent the shoot is by the time of infection, the greater will be the feeding ground for the lac insect and the greater the expectation of a subsequent heavy lac yield, though naturally the extra yield of lac may not necessarily equal the extra tree growth yield, as other extraneous factors can intervene.

As moisture content, and consequential increase of growth is higher at all soil depths on the irrigated area, it also follows that not only the lac host trees tapping the lower levels but also the grass soil cover tapping the upper levels will benefit. Increase of grass will give an increase of humus decay, if as in this case, the increased yield will not all be reaped as hay, resulting in an increase in the organic compounds of nitrogen, phosphorus, and potassium which will be carried down in solution into the soil for extra benefit to both crops. The increased grass crop will also help to prevent soil losses by erosion.

Another point to note is that in the case of soil pits 1 and 3 the few pieces of stone met with at the 6' levels were accretions in an iron and alumina pan. Their presence has made little appreciable difference to the moisture content as compared with the 3' levels whereas in soil pits 4, 5 and 6 the stones were part of a gravelly sub-soil—which has caused a serious drop in the moisture content.

It illustrates the fact that provided the iron pan is not impenetrable, it does not hinder tree growth, whereas a gravelly soil by draining away and so lowering the soil moisture content is a hindrance.

It is also possible that irrigation may take the iron pan down to a lower level, but as the conditions under which pan is deposited are very variable it would require a long and careful investigation to ascertain the effect of irrigation on the depth of pan formation in this case.

On the other hand, if the un-irrigated land were to be irrigated the increased moisture content of the soil would cause a more rapid weathering of the gravelly subsoil of gneissic origin by the disintegration of the felspars into clays.

While the abnormally dry April weather has affected the moisture content of the 1' depth samples, the 3' levels and the 6' levels do not appear to have been effected much, in fact, they are very nearly in equilibrium as is illustrated by the irrigated plots. This explains why trees can put forth leaves in the hottest and driest time of the year, as their moisture reserves are drawn from the lower soil levels.

Finally it is of interest to note that the moisture percentages of the 3' and 6' levels of the irrigated areas, increase in the middle and lower pits as compared with the upper pit. This is attributed to seepage of surplus water from above so that a better growth may be expected as one descends the hill, if other soil conditions remain the same.

Soil samples are to be taken again in July, and at the end of the monsoon rains, in order to obtain a complete picture of the effect of contour trenching upon moisture content at different times of the year.

N.B.—The above report has been corrected to conform with helpful criticism made by the Director of the Bureau of Soil Science, Harpenden, England.

Santara 15, and Pogamara gara (Bamiaburu irrigated area) and Protected Forest 25 and Ankua 4, near Salai (controls).

The object of these tests taken between the 19th and 21st May 1938, when the *sal* seeds were falling, was to discover whether better conditions for their germination prevailed in the irrigated area or without it in former comparable areas. Also to discover if irrigation increased the moisture content of the soil at lower depths,—sample scrapings of not more than $\frac{1}{2}$ " depth, of the soil were tested for moisture content to prove the former, and samples at lower depths for the latter.

Difficulty was experienced both in the irrigated area and in Protected Forest 25 in finding areas having a good depth of soil free from stones or rock, as these would upset the tests. Eventually a pit was dug, 133 yards from the trench in Pogamara gara and another in Santara 13, 43 yards from the trench just above the Research Thinning Plots, but samples could only be taken up to 2' depth. In Ankua 4, the soil was deeper. Preceded by lighter showers earlier in the month, .4" rain fell on the 12th May at Bamiaburu, and another heavy shower of .5 inch on the 16th instant, just after the areas there had been selected. As under normal conditions Salai would expect to get quite as much rain, if not more than Bamiaburu, from its proximity to the high hills of Dua and Indian Iron Mines in the East and Budha Buru in the West, all well over 2,000', if Bamiaburu received more rain from these

two storms than Salai, it is due to the experiment, not to its more favourable topographical position. In fact, the storm of the 16th came from the Salai direction, where it had rained. It is also reported that a light shower fell on the 20th evening at Bamiaburn, before the second soil scrapings were taken in the Pogamara gara and Santara 13.

Care was taken in the selection of each site, especially in the control areas, to see that the ground was well covered with grass which would retard evaporation to give a high moisture value.

The results of the soil moisture tests are shown below:—

Percentage of soil moisture.

	Control Plots.		Irrigated.	
	Protected Forest 25.	Ankua 4.	Pogamara gara.	Santara 13.
Surface scraping .	8.0	4.8	16.1 (10th May) 16.6 (21st May)	16.1 (10th May). 13.3 (21st May).
1'	11.0	12.0	16.6 . .	12.0
2'	13.8	13.8	13.8	16.0
Date on which samples were taken.	20th May, 9 A.M.	20th May, 8 A.M.	19th May, 9 A.M.	19th May. 10 A.M.

The chief thing to notice is the comparative dryness of the surface scrapings of the control plots, especially those of Ankua 4. An inspection of the road surface nearby, seemed to show that the ground had received only a little rain from the storm of the 16th.

On the other hand the Pogamara gara and Santara 13 surface scrapings show high moisture contents, higher than the samples at 1' and 2' depth. These high moisture values were due to the rains already mentioned. While digging the pits it was noticed that the rain had penetrated the first 4"-5" of the soil. It is interesting to note that the moisture values of the 21st May are lower in both cases than those of the 19th. This is probably due to the last evaporation which occurred between the 19th and 21st, with only a very light shower ('03 inch) on the 20th evening, to counteract it.

The lower surface scraping moisture values for Santara 13, as compared with Pogamara gara, may be due to taking the samples one hour later on the same day with an hour's extra sun drying the surface.

The results show that the conditions in the trenched areas of Bamia-buru were much more favourable for germinating the perishable sal

seeds than were the conditions in Protected Forest 25, and Ankua 4. The moisture contents would scarcely be high enough to germinate the seeds (germinating tests for seeds are carried out on soaked blotting paper), but, once the showers which were falling fairly frequently at the time, had started the germination, there would be sufficient moisture in the soil to enable the seed to take root.

The Divisional Forest Officer records that it rained every day after the 21st for the week he was there, so that conditions for seed germination became even more favourable than at the time of the experiment. In Chota Nagra, no rain fell between the 20th and 23rd, when a heavy shower fell. Thereafter, it would seem that the rainfall throughout the Singhbhum forest area became general.

As regards the samples taken at the 1' and 2' levels there is nothing striking to observe except the 2' level of Santara 13, which records 16 per cent. moisture. This may be due to the fact that the pit was only 43 yards from the trench, whereas the Pogamara gara pit where 13·8 was registered was further away. On the other hand, the level of the Pogamara gara shows a high percentage moisture 16·6 at the 1' level, with an inexplicable drop to 13·8 in the 2' level. It would almost seem as if the results for the 1' and the 2' levels should be reversed to be more consistent with the Santara 13 records.

It will be necessary to repeat these records, especially for the lower levels.

II.—SYSTEMATIC.

Palamu Division.

In plantations from seeds of chir pine (*Pinus excelsa*)^{*} two kinds of pine were noticed, the leaves and cones of one being longer than those of the other. The former is true *P. longifolia*, the identification of the latter is still under investigation at the Forest Research Institute, Dehra Dun.

III.—PATHOLOGY.

Fungal diseases in sal in Singhbhum forests are extremely common, especially in the drier Hill Sal areas. There is a great prevalence of unsoundness and heart rot while dead trees are a common phenomenon. Examination suggests that not only is the heart rot due to fungal attacks but also the deaths.

*The tentative identification of *Pinus excelsa* was given on a specimen without cones taking into consideration the Wood Technologist's opinion that the wood resembled that of *P. excelsa*. Since then however complete specimens prove that the identification is not correct and that the pine is certainly not *P. excelsa*. The cone and leaves cannot, however, be matched at Dehra and are being sent to Kow. The D. F. O. has sent complete timber samples of the two species and these are being investigated.

During the last 2 or 3 years specimens of fungal sporophores have been sent to the Research Institute at Dehra Dun and requests made for a Mycologist to be sent to Singhbhum for examining unsoundness and mortality in sal. Dr. Bagchee, the Mycologist at Dehra Dun, accordingly toured in Saranda, from the 23rd January to 3rd February 1938, and then went to Kolhan division.

Dr. Bagchee has not yet drawn his report on the fungal attack on sal trees of Singhbhum forests. Mr. F. C. Osmaston, the Divisional Forest Officer, Saranda, who accompanied Dr. Bagchee in his tour writes as follows :—

"A full report cannot be made for some time as much will depend on the results of cultures to be taken from specimens collected, while a final report can only be made after cultures have successfully been infected into sound sal when only can the life history of each fungus be satisfactorily ascertained.

In Saranda, unsoundness seems to be worst on white shale soil where sabai grass is usually common and this unsoundness is perhaps accentuated if there are signs of previous cultivation. Unsoundness is least prevalent on those red soil slopes, so often lateritic or derived from iron ore beds. In such areas unsoundness may be as little as 10 per cent. say, while in bad shaly soils it may be as high as 75 per cent. or more. In deep soiled valleys (unless in white shales), especially red soils, unsoundness is usually not pronounced unless the trees are very old. (Lateritic soils are indicative of high rainfall and the fact that unsoundness is least on them seems to suggest that unsoundness is correlated with drought. Ed.)

Mortality is often most noticeable in mature stands of good quality where the soil is a dead red loam.

In Saranda there seem to be 3 main active fungi that cause death or unsoundness. These are (as far as Dr. Bagchee could confirm) :—

- (i) *Polyporus shoreæ*.
- (ii) *Fomes tricolor*.
- (iii) *Trametes incerta*.

Polyporus shoreæ.—This is the sal root fungus, which rots the root system, eventually causing death but does not necessarily cause unsoundness as it advances only slowly up the stem. It is mainly responsible for deaths of sal. It appears to develop best in deep soils where quality is good and to kill large trees. Dr. Bagchee in the field failed to find any rhizomorphs. Infection may be due to wind dispersal of spores only or to contact by infected roots as well."

The Conservator is of opinion that *Polyporous* is definitely a fungus of rich deep soils where sal thrives well and is more prevalent in loamy soils. It generally attacks either isolated trees or groups at once and that death takes place within 2 rainy seasons. Healthy trees and poles are attacked and killed outright. The attack broadens gradually from a centre but does not interfere with young regeneration.

Fomes tricolor.—This fungus is very common and is found in all types of sal forest in Saranda, though it is undoubtedly least common in the red iron soil slopes. It seems to be a heart rot and perhaps only a heart rot, and so may not be concerned in the death of a tree. On the other hand it seems to advance from the root upwards. It may be one of the causes of dry rot in sal timber and to be capable of spreading after timber is felled and converted to sleepers or scantlings.

It is also possible that it enters a tree through the stems and proceeds downwards. For example saplings and young trees often have a knotty appearance with multitudinous epicormic branches. There is some evidence that rot enters and develops down the stem from these knots.

Trametes incerta.—This fungus seems to be a heart rot only and one that does not kill a tree. It appears to be more local than either *Polyporus shorea* or *Fomes tricolor*. It seems mainly to frequent white shaly solid localities where sabai grass is plentiful.

Attacked trees seem to have a crooked appearance with knotty protusions from which epicormic branches spring and whence the sporophores emerge. It is therefore possible that unhealthy knotty looking poles are infected with *Trametes incerta*. Clear felling in any area infected with *Trametes incerta* would be a control measure.

The Conservator remarks that *Fomes* and *Trametes* are attackers of badly grown poor type sal on hill areas which are or have been desiccated by drought and fire, etc.

Experiments are to be initiated with control plots for the thorough study of these fungi and for devising means of overcoming the loss they occasion. In the belief that drought is probably the chief contributing factor regulating the attack it is proposed to lay out experimental plots, with contour trenches to see if irrigation will make the sal more resistant to attack. Infected poles will be cut back to see how long the new shoots will remain immune from attack when a plentiful supply is assured.

CENTRAL PROVINCES AND BERAR.

There is no special officer in the province for conducting forest botanical research nor do the necessary facilities exist. If a suitable officer could be spared, Balaghat Forest School would be the most suitable

place for starting a nucleus of a properly organised Herbarium and a Botanical Garden which will fulfil a long-felt demand of the department. For the present all identification and research work for the province is done by the Forest Research Institute, Dehra Dun.

The following observations are reported from divisions :—

Amracti.—The prevalence of *Fomes pappianus* in the babul plantations seems to be due not so much to congestion as to soil factors. Very heavy and ill-drained soil is not very conducive to the growth of this species and consequently in such areas the plants are very sickly and easily succumb to fungal attacks whereas along well-drained streams they are comparatively free.

Balaghat.—There appears to be a special variety of *Bauhinia variegata* growing in this division. It has more or less uncleft and yellowish green glabrous leaves, instead of the usual cleft and greenish-blue glaucous leaves. Specimens will be sent to Dehra Dun to ascertain if this is only a variety of *Bauhinia variegata* or a new species of *Bauhinia*.

Bilaspur.—Some dying back of teak was noticed and specimens of dead twigs were sent to the Forest Research Institute to ascertain the cause of damage and suggest remedial measures. The dying back is observed to take place in late July and August and is followed by defoliation in September. A new flush of leaves appears soon after. Of the four possible causes of this dying back, viz., drought, frost, insect attack, and a secondary effect of defoliation; the last is thus automatically eliminated, because desfoliation follows dying back. Frost also does not seem to be the cause as it was observed that the shoots that died back were the growth of the spring (March-April) following the frost (January). Similarly drought could not be a cause as July-August, when the damage occurs, are by far the wettest months. Thus it would appear that the agency responsible for the damage is some insect and further investigations to confirm this are being carried out.

Besides the four possible causes mentioned, the dying back might also be the result of physiological drought, i.e., a condition under which although there is plenty of moisture present in the soil, the roots are unable to absorb it, or excessive transpiration by the young and succulent tips of the trees, as a result of strong hot winds that blow during a prolonged break. The investigation might take these factors also into consideration.

Mandla.—The common violet was found growing near Chouradadar in March. *Curcuma aromatica* was seen flowering in the sal forests in April, which is considered early for this species.

North Chanda.—The climber *Aspidopterys cordata* was noticed to be very common in regeneration areas of the Moharli range.

CHAPTER IV.

FOREST ENTOMOLOGY.

BENGAL.

The insect girdling the collar of young *Cryptomeria* plants in Takdah Range, Darjeeling division, has been identified as the larva of *Phassus* sp. (*Hepialidae*).

The incidence of damage by the Champ Bug (*Urostylis punctigera*) was less during the year. Investigations on a defoliator of *Chukrassia tabularis*, and on the larvae from girdled mahogany (*Swietenia macrophylla*) were continued during the year.

BIHAR.

Bagworms, *Clania* sp., attacked young foliage of *Callistemon*, *Casuarina*, *Dalbergia sissoo* and *latifolia* at the end of July 1937 in Hinoo nursery. A young shoot of *Eucalyptus citriodora* about 6" in length was completely destroyed in two days.

Lagerstroemia flor-reginae was attacked early in September 1937 by *Trabala vischou* Lef. (Lasiocampidae). As the area of attack is small the remedy consists in hand-picking or alternatively spraying with lead arsenate.

White Ants.—In the Experimental garden at Hinoo, it has often been noticed that exotics are more susceptible to white ant attack than indigenous species. Especially *Eucalyptus* and Cypressos have been badly attacked. Watering with 5 per cent. Phenyl with Karanj cake every three days, helps to reduce the attack.

Forest Zoology.—The tiger census in the Palamau forests, on April 30th, and May 1st, showed 19 tigers and 10 tigresses.

CENTRAL PROVINCES AND BERAR.

Increasing damage from browsing by game is reported everywhere and is attributed to an increase in the number of deer as a result of stricter game laws.

Defoliators of teak.—The following notes summarising the entomological research by the Forest Research Institute at Nilambur are given for general information :—

The parasites of teak defoliators released in Nilambur in 1937 are *Trichogramma* sp. (Burma), an egg-parasite of *Hapalia machaeralis* *T. minutum*, an egg-parasite of *Hyblaea puera* and *Cedria paraloxa*

larval parasite of *machaeralis*. These species have alternative hosts and it is expected that the colonisation will be successful.

The pre-existing parasitism of *machaeralis* and *puera* is also recorded.

The vegetation of teak plantations has been studied and lists of species which are (a) desirable, and (b) undesirable are given with reasons for the classification.

Of the species of plants which are considered desirable in teak plantations, because they are food-plants of defoliators that are alternative hosts of parasites of *machaeralis* and *puera*, the following occur in the Central Provinces.

**Achyranthes aspera*, *Anthocephalus cadambe*, Bamboo, *Bauhinia racemosa*, *Boehmeria platyphylla*, *Borassus flabellifer*, *Casuarina graveolens*, *C. tomentosa*, *Cassia fistula*, **Cedrela toona*, *Celastrus paniculata*, *Dalbergia sissoo*, *Diospyros montana*, *D. turp*, *Ehretia laevis*, *Elaeodendron glaucum*, *Flemingia paniculata*, *Grewia* spp., **Helicteres isora*, **Holarrhena antidysenterica*, *Jasminum pubescens*, *Lagerstroemia parviflora*, *Leeca* spp., *Ougeinia dalbergioides*, *Pavetta indica*, *Solanum* sp., *Terminalia bellerica*, **Xylia xylocarpa*; and of the cultivated plants *cotton, rice, sugarcane, tobacco, *castor and *mulberry.

Species marked thus (*) support defoliators which are alternative hosts of parasites common to both *machaeralis* and *puera* and are thus potentially most useful.

Of the species of plants which are considered undesirable in teak plantations because they are alternative food-plants of *machaeralis* and *puera* or of other pests of teak, those found in the Central Provinces are :—

Gmelina arborea, *Lantana camara*, *Premna latifolia*, and *Vitex negundo*.

The efficiency of the control of *Hapulia machaeralis* by parasites may be considered satisfactory in Nilambur but the control of *Hyblaea puera* is still deficient.

ORISSA.

Young *asan* (*Terminalia tomentosa*) plants, raised in *rab* sowings in Barapahar division, were attacked and killed by defoliators.

CHAPTER V.

UTILIZATION AND ECONOMIC RESEARCH.

ASSAM.

I.—GENERAL WORK OR ADMINISTRATION.

Mr. S. M. Deb held charge of the post of Utilisation Officer during the year under review.

II.—EXPERIMENTAL ACTIVITIES.

(1) Wood Technology.

The collection of wood specimens in connection with the work in progress on Assam timbers at the Forest Research Institute, Dehra Dun, was accelerated.

The Wood Technologist of the Forest Research Institute visited almost all the divisions of the Province immediately after the close of the year in connection with the same work, viz., the anatomical study of 183 species.

(2) Timber Seasoning.

As mentioned in the Annual Report for 1935-36, the Surma Valley Sawmills have finally agreed to install a seasoning kiln.

Dr. S. N. Kapur, Officer-in-charge of the Seasoning Section of the Forest Research Institute, Dehra Dun, paid a visit to the mills towards the close of the year under review, and gave necessary advice. A kiln with two chambers, each=11' 6" wide, 20' high and 28' long, with a capacity of 10 tons of $\frac{1}{2}$ " planks, and with an operating room 27'×14' is under construction. The estimated cost is Rs. 40,000 (forty thousand rupees).

The erection is likely to be completed by the end of October 1938.

The Assam Railways and Trading Company's Sawmills at Margherita afford an example of how timber should be properly stacked for air-seasoning with the result that 50 per cent. higher prices are obtainable after one year's seasoning as against the green material usually supplied locally.

(3) Timber Testing.

Now that the planting of teak is being steadily increased, steps are being taken to find out the strength and working qualities of Assam teak as compared with that of Burma and elsewhere.

In view of the prospective use of treated sleepers, the following species have been selected for test at the earliest possible opportunity, as to their suitability for sleepers from the points of view of strength and capacity to absorb the requisite amount of preservative:—

Gogra (Schima wallichii).

Sida (Lagerstramia parviflora).

(4) Wood Preservation.

Some 15,000 (fifteen thousand) Metre Gauge hollong sleepers have been cut by the Assam Railways and Trading Company for use on their own line, after pressure treatment in their treating plant at Margherita with a mixture of 50 per cent. creosote and 50 per cent. crude oil.

(5) Wood Working.

(i) The following species were supplied for pencil making tests:—

Bonsum (Phæbe goalparensis).

Titachapa (Michelia champaca).

Gunscroi (Cinnamomum glanduliferum).

Toon (Cedrela toona).

Gogra (Schima wallichii).

Sida (Lagerstramia parviflora).

Haldū (Adina cordifolia).

Uriam (Bischofia javanica).

Of these, *uriam (Bischofia javanica)* was reported to be most suitable for the manufacture of pencils, and *haldū (Adina cordifolia)*, *toon (Cedrela toona)*, *bonsum (Phæbe goalparensis)* and *titachapa (Michelia champaca)* were found to turn out good pen-holders.

(ii) Three sets of tool-handles, as are ordinarily required by the Indian Railways, were converted from *ping (Cynometra polyandra)*.

The East Indian Railway indicated a liking for the biggest type of handles made of this wood by ordering a supply of a small quantity of such handles.

(iii) A firm has found *bhelu (Tetrameles nudiflora)* a good substitute for the Andamans *dhup*, for the manufacture of portable cabinets covered with leather or leatherette.

(iv) In indigenous handlooms used in home industries in the Assam Valley, the use of *bonsum (Phæbe goalparensis)* for shuttles is increasing.

(v) *Bael (Aegle marmelos)* has been found to make excellent handles for chisels and small hand-planing tools.

(vi) The sapwood of *karol* (*Kayea floribunda*) has been found to make good handles for small tools.

(vii) *Sutrong* (*Lophopetalum fimbriatum*) makes excellent light ceiling boards capable of taking a high class polish.

(viii) Furniture makers are being advised to make drawers of wardrobes and of cabinets, meant to protect respectively woollen clothing and valuable documents from vermin, with *gunseroi* (*Cinnamomum glanduliferum*).

(ix) *Kurta* (*Palaquium polyanthum*) makes a very good movable deck for country boats. The edges of planks do not deteriorate although badly exposed to the sun, moisture and constant rough use. This timber is therefore being recommended for bridge flooring after air-seasoning.

(x) *Rata* or *amari* (*Amoora wallachii*) is a favourite timber with the Surma Valley Sawmills for making furniture.

(xi) For the construction of articles such as camp furniture for which elasticity combined with strength and toughness is a desideratum for rough handling, *hatia* or *boga-poma* (*Chukrasia tabularis*) has been found a splendid timber.

(xii) *Jhalna* or *hollock* (*Terminalia myriocarpa*) has been found satisfactory for bottom boards, and is also likely to be used by one Railway for the construction of skeleton frames for carriages.

(xiii) The same Railway was also convinced of the utility of *bonsum* (*Phæbe goalparensis*) for panelling and ceiling in carriages, but the price and freight of this material from one end of the country to the other proved a bar to its economic use.

(xiv) Samples of *titachapa* (*Michelia champaca*) and *bonsum* (*Phæbe goalparensis*) have been sent to a firm in Great Britain, through the Timber Adviser to the High Commissioner for India, for testing their suitability for making engineers' patterns, such as models of aeroplane engines, motor engines, locomotive parts, etc.

(6) Match woods.

The Assam Match Company's Factory at Dhubri does not like to use any indigenous timber other than *simul* (*Bombax malabaricum*).

A Match Company of Calcutta has however agreed to use *bhelu* (*Tetrameles nudiflora*), *pitali* (*Trewia nudiflora*) and *kadam* (*Anthocephalus cadamba*), and has placed a trial order for the supply of these species.

(7) *Wood for packing cases.*

The Venesta Factory, Kamarhati, has after all taken to the use of *simul* (*Bombax malabaricum*) and *bhelu* (*Tetrameles nudiflora*) for chest battens. Its dislike for these timbers, because of the influence of tradition, was noted in last year's Report.

The Calcutta dealers who so long preferred *simul* (*Bombax malabaricum*) and *bhelu* (*Tetrameles nudiflora*), have been convinced of the worth of several other species, and they are now taking also *kadam* (*Anthocephalus cadamba*), *pitali* (*Trewia nudiflora*), *dimaru* (*Ficus* spp.), *barpat* (*Ailanthus grandis*), *scleng* (*Sapium baccatum*), *satiana* (*Alstonia scholaris*), *bonjalakia* (*Cryptocarya amygdalina*) and *bonhonalu* (*Cryptocarya floribunda*).

(8) *Plywood and veneers.*

Makai (*Shorea assamica*) and almost all varieties of *sapas* (*Michelia* spp., *Talauma* spp. and *Manglietia* spp.) make excellent decorative plywood, ornamental veneers and laminated panels.

(9) *Paper pulp.*

(a) *Bamboo.*

From a preliminary investigation, it appears that within the Province approximately 252,000 acres are covered by not less than 25 varieties of bamboo of which *muli* (*Melocanna bambusoides*), *kako* (*Dendrocalamus hamiltonii*), *khang* (*Dendrocalamus longispathus*) and *mirtenga* (*Bambusa tulda*) predominate, and are therefore important from the pulp industry point of view.

About 56,000 tons of bamboos can be made available for annual supply, provided pulp making factories be established at suitable centres within or in the vicinity of the sources of supply.

(b) *Grass.*

Imperata cylindrica seems to cover about 205,000 acres of land all over the Province. The approximate annual supply of this species for pulp and paper manufacture may be estimated at 102,500 tons.

So long as pulp mills at suitable sites within the Province are not erected there is little chance for this material being utilised for the purpose, as transit charge to established mills is prohibitive.

(10) *Minor forest produce.*

Pishachban (*Eupatorium odoratum*).—As mentioned in last year's Report, 4 maunds of flowers of *Eupatorium odoratum* were supplied to

the Bio-Chemist, Forest Research Institute, Dehra Dun, for distillation of essential oil, and he reports as follows :—

" The flower heads of *Eupatorium odoratum* when received here were in a process of decomposition but were distilled immediately for their oil content. The yield of the oil is very very low and not enough for chemical examination.

In order to avoid the loss of oil during transit, due to decomposition or excessive drying, I would suggest your distilling flowers on the spot."

Bakhal bil (*Millettia pachycarpa*).—10 pounds air-dried thin roots were sent to the Bio-Chemist, Forest Research Institute, Dehra Dun, for rotenone test and the following is an extract from his report :—

" I have the honour to report that the samples of *Millettia pachycarpa* roots sent along with your letter No. B/859, dated the 19th November 1937, yielded 4·3 per cent. of total ether extract and 2·8 per cent. of rotenone. These results appear encouraging, especially when compared with the previous samples examined."

Guttapercha (*Palaquium polyanthum*).—The following report from the India Rubber, Gutta Percha and Telegraphs Works Co., Ltd., is in addition to what has been stated in the last year's Report :—

" The sample referred to has been examined in the Works. They state that when it is washed in hot water it becomes very adhesive and remains soft for a considerable while. The resin content appears to be very high and the proportion of gutta or rubber is not likely to exceed 10 per cent.

It does not resemble any of the guttas with which they are most familiar, and they could not use it to advantage.

They add, however, that users of gum chicle may find it interesting nevertheless, as it has similar properties, chiefly a low softening point."

III.—COMMERCIAL ACTIVITIES.

1. *Timber Trade.*

(a) Supply of woods to Railways.

(1) *Sleepers*—

Previous to the recent intervention of the Forest Department and Messrs. Himatsingka Timber Ltd., the Assam Bengal Railway used to purchase teak sleepers for their bridges and main crossings. These have now been replaced by sal.

Nahor (*Mesua ferrea*) and *hollong* (*Dipterocarpus macrocarpus*).—The Assam Railways and Trading Company, Ltd., have cut about 10,000 metre gauge sleepers of *nahor* for use in their own line and also some 15,000 *hollong* for utilisation after pressure treatment.

(2) *Timber other than sleepers*—

Purchasers' Agency.—About 600 tons of converted material mostly from the following species were supplied to the Assam Bengal Railway and the Tezpur Balipara Railway :—

Bonsum (*Phoebe goalparensis*).

Tilachapa (*Michelia champaca*).

Sal (*Shorea robusta*).

Amarि (*Amoora wallichii*).

Haldū (*Adina cordifolia*).

(b) *General*.

Internal consumption.—There has been a steady increase in the use of Assam timbers for plywood tea chests at the two local veneer mills.

Export.—The Surma Valley Sawmills did increase business in export trade. Improved export of Assam timber from all sources amounted to about 31,000 tons of wood consisting mainly of—

Sal (*Shorea robusta*).

Sam (*Artocarpus chaplasha*).

Ajhar (*Lagerstromia flosreginae*).

Amari (*Amoora wallichii*).

Bonsum (*Phoebe goalparensis*).

Gurjan (*Dipterocarpus turbinalis*).

Tilachapa (*Michelia champaca*).

Gamar (*Gmelina arborea*).

Sutrong (*Lophopetalum fimbriatum*).

Khokan (*Duabanga sonneratoides*).

Boga-poma (*Chukrasia tabularis*).

Poma (*Cedrela toona*).

Simul (*Bombax malabaricum*).

Bhelu (*Tetrameles nudiflora*).

2. *Trade in minor forest produce*.

Cane.—The outlook of the trade in cane, which is virtually Assam's monopoly in the country, has been much brighter.

The prices for all varieties have gone up by 15 to 50 per cent.

Bamboos.—The demand from the paper pulp industry remains stagnant at only 2,000 tons a year, but from the neighbouring districts of Bengal for domestic use has considerably improved.

Grass.—There is a keen demand for thatching grass in the Surma Valley and Lower Assam.

Owing to the extensive use of corrugated iron sheets for roofs and to the Assam Oil Company using straw for packing their kerosine canisters in railway wagons, the consumption of grass seems to be steadily decreasing in Upper Assam.

Lac.—With a depressed market due to over-production in other lac growing Provinces and the tricks of the middlemen dealers, the local growers are receiving little encouragement. This situation is now under Government's consideration.

Rubber (Ficus elastica).—Superior quality material from South India is selling in Calcutta at a price which is lower than the cost of collection of Assam rubber, hence the lessee has no other alternative than to suspend operations till matters improve.

Honey.—Paucity of normal crop in certain areas was responsible for high prices.

Bees' wax.—The market was very strong with prices moving in the favour of sellers.

Herbal drugs.—*Raktachita (Plumbago rosea)*.—Prices increased from Rs. 25 in last year to Rs. 40.

Nut-vomica.—A sale was made for the first time. 1 maund and 18 seers of *Nut-vomica* seeds were sold for Rs. 17-6-6 at Rs. 12 per maund.

Charlmugra (Hydnocarpus kurzii) seed.—Production was below normal, immature seeds were collected by the lessees and there was lack of enthusiasm on their part to place them on the market in time for sale; hence trade was extremely dull.

Pipul (Piper longum).—Although the market was active, two of our Mahals failed to attract tenders. The reason is attributed to the scarcity of supply.

Agar (Aquilaria agallocha).—The market was as strong as last year. A new mahal was created in North Kamrup.

Boga-medeloa (Tephrosia candida).—One maund of *boga-medeloa* seeds was sold.

Nahor seeds (Mesua ferrea).—A *nahor* seeds Mahal including Sib-sagar, Sadiya and Lakhimpur was sold for the first time.

Rhinoceros horns, skin and hoofs.—Two horns weighing 198 tolas were sold for Rs. 1,160 or Rs. 336-4 per lb. Five maunds of skin in a

damaged state due to decomposition were sold for Rs. 30 and 11 hoofs for Rs. 3/-.

Ivory.—15 maunds, 10 seers, 9 chattacks and 2 tolas ivory were sold in auction for Rs. 5,854 or Rs. 9-9-5 per seer against Rs. 10-10-6 in 1936-37 and Rs. 9-8-6 in 1935-36.

3. Railway freights.

Timber.—Reduction in Railway freight has been obtained for most of the forest produce. Previous rates were too high for trade and the new rates will benefit the Railways as well as the Department.

4. Publicity, propaganda and commercial advice.

(I) In the efforts to encourage an extensive use of Assam timbers, a great step forward in the matter of propaganda was made during the year under review as consuming and distributing centres were visited by the Utilisation Officer with samples of Assam timbers, many of which proved attractive to stockists.

(II) Next to *sal* (*Shorea robusta*), as regards quantity available, comes *hollong* (*Dipterocarpus macrocarpus*) but its internal consumption is only a negligible fraction of the annual possibility. The so-called *gurjan* in the Calcutta market from Burma, comprises several varieties of *Dipterocarpus* including *hollong*. The demand for such timbers in the Calcutta market is for mill sawn material, whereas unfortunately there is no suitable sawmill in our *hollong* areas to meet the demand. Formerly, transport charges were prohibitive. These have now been reduced, and attempts are being made to interest industrialists in the matter. The question of re-opening the sleeper treating plant at Naharkatiya was under discussion after the close of the year.

(III) A firm who had been using a huge quantity of boards for packing cases from Korea (Japan) was approached and presented with samples of *bhelu* (*Tetrameles nudiflora*) and *simul* (*Bombax malabaricum*) shooks. The Manager was strongly urged and agreed to buy almost all his requirements made of *bhelu* on the Utilisation Officer's recommendation from millers who obtain their supply of this species from the forests of Assam.

(IV) For the first time, *khair* (*Acacia catechu*) trees were sold for the manufacture of cutch and *katha* in the Hailongao division during the year. A working scheme for *khair* areas has been prepared after enumerations.

(V) Some Railway engineers were personally approached, while others were written to, urging the suitability of Assam timber for their work.

(VI) Efforts to place firewood in local markets in large quantities at reasonable prices consisted in visiting production centres, giving necessary advice to suppliers and getting the Railway freight reduced by 20 per cent.

(VII) Assistance was given in the disposal of *sal* from Kamrup and Goalpara divisions particularly in settling transit charges with good results.

(VIII) A little over a crore of bamboos may safely be estimated as the normal annual output of our bamboo-bearing areas, of which about 50 lacs are annually extracted for domestic use.

The balance could therefore be used as pulpable material had it been possible to extract and deliver the same to pulp and paper mills at workable cost. Transit rates for long distances at present prevents this utilisation.

The solution is therefore to get some pulp making mills set up near the sources of raw material and with this object in view negotiations are now in progress with Calcutta.

(IX) An exhibition of curios manufactured from Assam ivory by those industrialists who attend our auction sales for purchase of elephant tusks was arranged at the office of the Forest Utilisation Officer. It was largely visited by gentlemen of the town who highly appreciated the exhibits and greatly admired and encouraged the manufacturers.

(X) Technical advice was given to sawmillers and other industrialists as well as to traders, big or small, and also to consumers.

(XI) Sellers were put in touch with purchasers.

5. Results of the efforts to increase the sale of Assam timbers.

(I) During the year under report improvement was effected in prices of the following :—

(a) Hardwoods—

- Bonsum (Phoebe goalparensis).*
- Titachapa (Michelia champaea).*
- Amari (Amoora wallichii).*
- Ajhar (Lagerstroemia flos-regiae).*
- Gamar (Gmelina arborea).*
- Poma (Cedrela toona).*
- Hollock (Terminalia myriocarpa).*
- Sal (Shorea robusta).*

(b) Softwoods.—After a long struggle with the Calcutta millers prices of woods for packing cases have been raised.

6. *Miscellaneous.*

(i) *Departmental sleeper supply.*—The aim and object of the departmental contract for sleepers was fully explained in last year's report. More lamentable was this year's supply from the indigenous contractors. Only 594 out of 50,000 sleepers were supplied by them and the balance was made up from other sources.

(ii) *Railway conferences.*—No less than 5 conferences with Railways were arranged for and attended to discuss the possibility of introducing such rates of freight as would be mutually workable in the joint interest of both traders and transporting agencies.

(iii) *Collection of specimens.*—A large number of specimens were collected for the proposed forest products museum.

(iv) *Supply of samples.*—Samples of various forest products intended for commercial and industrial trial for exhibits in museums and also for educational purposes were liberally distributed.

(v) *Publication.*—The writing of a hand book of forest products of Assam has been taken up.

(vi) *Enquiries.*—More than three hundred miscellaneous enquiries were answered on timber, bamboo, cane, lac, agar wood, resin, honey, bees' wax, fish poisons and drugs.

(vii) *Identification.*—14 pieces of timber were identified, 12 for the Assam Bengal Railway and 2 for Messrs. Himatsinghka Timber, Ltd.

They included *bonsum* (*Phæbe goalparensis*), *khokan* (*Duabanga sonneratioides*) and *phulchapa* (*Manglietia insignis*). Sample sent as *bonsum* (*Phæbe goalparensis*) was identified as *khokan* (*Duabanga sonneratioides*).

At the request of the Deputy Controller of Stores, East Indian Railway, a few varieties of cane were identified before him in his office. Samples tendered by his contractor as Malacca cane were found to include about 10 per cent. of Malacca cane, 20 per cent. of *sundi bet* and 70 per cent. of *tita-bel*, the latter two being natives of Assam forests. The strength, durability and utility of *tita-bel* for the purpose of baskets meant for such rough wear as carrying of coal, earth and ballast, were shown to him and he was told how to identify *tita-bel* and also to test the mechanical strength of cane baskets which were appreciated by him. He has agreed to insist upon the supply of Assam *tita-bel* in his future call for tenders for cane baskets.

(viii) *Liaison.*—The usual liaison was maintained with the Provincial Silviculturist and Botanical Officer; Specialists at the Forest Research Institute, Dehra Dun, Director of Commercial Intelligence

and Statistics, Calcutta ; Director, School of Tropical Medicine, Calcutta ; the Officer in-charge, Commercial Museum and Publicity Department, Corporation of Calcutta. Acknowledgments are due for help from all these sources and also to Mr. A. K. Bose, Superintendent, Rates, Development and Publicity, Eastern Bengal Railway, and Messrs. R. G. Munson, Chief Operating Superintendent and R. S. Vipan, Chief Commercial Manager, Assam Bengal Railway, for their sympathetic co-operation in the matter of removing high freight rates for the development of trade in forest products.

(ix) *Aims and achievements.*—As some sections of the public appear to be still ignorant of the aims and objects of the Utilisation Branch and also of the benefits of its activities the remarks made last year in this connection are repeated below :—

The primary object is to develop the utilisation of all the natural resources of our forests and to place an increasing supply of marketable products within the reach of the public. Thus aim is to be so attained as in the process to bring in to Government the full value of the same.

The beneficial effects should be found in the improvement in prices of raw materials and the consequent increase of the net revenue.

BENGAL.

I.—GENERAL WORK OR ADMINISTRATION.

The post of Forest Utilisation Officer, Bengal, was held by Mr. C. T. Trigg, Deputy Conservator of Forests, from 1st April 1937 to 21th November 1937, and Mr. S. Chandhuri, Deputy Conservator of Forests, from 25th November 1937 to 31st March 1938.

II.—COMMERCIAL ACTIVITIES.

Sales.

(a) *B. G. sleepers.*—Orders for the supply of 5,000 B. G. sleepers were received during the year under report at rates of Rs. 4-11-0 and Rs. 4-13-0 each f.o.r. loading station.

(b) *M. G. sleepers.*—An order for the supply of 10,000 sleepers was received at Rs. 1-15-3 each f.o.r. despatching stations.

(c) *Light N. G. sleepers.*—An order for the supply of 1,000 Light Narrow Gauge sleepers was received at Rs. 0-13-0 each f.o.r. despatching stations.

(d) *Special sleepers.*—An order for the supply of special sleepers to the value of Rs. 19,378-4-0 was received at rates varying between Rs. 1-10 0 to Rs. 10-7-6 each sleeper f.o.r. loading stations.

(e) *Sal logs*.—Round sal (*Shorea robusta*) logs to the value of Rs. 33,965-0-0 were supplied to the various railways and Government firms.

(f) *Sawn sal timber*.—Sal (*Shorea robusta*) planks and scantlings to the value of Rs. 1,597-8-0 were sold to various firms during the year under report.

(g) *Sal ballahas*.—An order for the supply of 4 sal (*Shorea robusta*) ballahas to the value of Rs. 148-8-0 was received during the year under report.

(h) *Birch*.—Orders for birch (*Betula alnoides*) squares and planks to the value of Rs. 1,482-11-0 were received at the rates of Rs. 1-2-0 and Rs. 0-15-0 per c.ft. f.o.r. loading stations.

(i) *Toon*.—Orders for the supply of sawn toon (*Cedrela toona*) timber to the value of Rs. 3,425-2-6 were received from various firms and Government Departments and were supplied from Kalimpong, Kurseong and Buxa divisions.

(j) *Sissoo*.—Orders for the supply of sissoo (*Dalbergia sissoo*) logs to the value of Rs. 6,400-0-0 were received and were supplied to the firms and railways concerned within the year under report.

(k) *Gurjan*.—Orders for the supply of gurjan (*Dipterocarpus turbinatus*) logs were duly received from the railways like the previous year during the year under report, and the total value of the supply from the Chittagong Hill Tracts division amounted to Rs. 10,195 only.

(l) *Gamari*.—Orders for the supply of gamari (*Gmelina arborea*) planks to the value of Rs. 2,168-12-0 were received during the year under report.

(m) *Jarul*.—Jarul (*Lagerstroemia flos-regiae*) scantlings to the value of Rs. 36-0-0 were sold from the Chittagong Hill Tracts division during the year under report.

(n) *Match-wood logs*.—Orders for the supply of siunul (*Bombax malabaricum*), pitali (*Tricia nudiflora*), kadam (*Anthoncephalus cadamba*), logs suitable for match manufacture were received from various match-manufacturing firms in Calcutta.

(o) *Miscellaneous timbers*.—Orders for the supply of mixed timbers such as pakkasaj (*Terminalia tomentosa*), chickrassy (*Chukrasia tabularis*), gumar (*Gmelina arborea*), lampatin (*Dubanga sonneratoides*), lali (*Amoora wallichii*), toon (*Cedrela toona*), chapalish (*Artocarpus chaplasha*), champ (*Michelia champaca*), willow (*Salix tetrasperma*), siris (*Albizia lebbek*), karam (*Adina cordifolia*), etc., to the value of Rs. 1,541-2-9, were supplied from Kurseong and Buxa divisions during the year under report.

(p) Civit.—An order for the supply of 20 tons of civit (*Sirintonia floribunda*) at Rs. 25 per ton f.o.r. Chittagong, was received from Messrs. Mansfield & Sons, Calcutta.

III.—EXPERIMENTS AND RESEARCH.

(1) Wood Technology.

A key for the identification of 31 Bengal timbers is being prepared at the Forest Research Institute, Dehra Dun. All species with the exception of one or two have been sent to Dehra Dun, and the rest will be despatched soon from divisions.

(2) Timber seasoning.

Cedrela toona.—Reports on 10 tons of forest grown toon (*Cedrela toona*) sent to the Utilisation Officer, Forest Research Institute, Dehra Dun, for kiln-seasoning experiment under Project VII, for comparison with road side toon, have not yet been received.

(3) Timber Testing.

(i) Logs of the following species were sent to Dehra Dun during 1931-35 for test under Project VIII (Veneer and Plywood).

<i>Terminalia tomentosa</i>	.	.	.	.	Kurseong.
<i>Arthocarpus cadamba</i>	.	.	.	.	Kurseong.
<i>Artocarpus chaplasha</i>	.	.	.	.
<i>Gmelina arborea</i>	.	.	.	.
<i>Lagerstroemia flor regiae</i>	.	.	.	.
<i>Michelia champaca</i>	.	.	.	.
<i>Dipterocarpus turbinatus</i>	.	.	.	.	Chittagong Hill Tracts.

(ii) *Castanopsis hystrix*.—A sample of this timber was sent from Darjeeling division in 1931-35 for test under Project VIII (Veneer and Ply-wood) and the following report has been received :—

" Peeled-green. Slight evidence of stain near sap. Free from insect attack and knots. Too fast grown. Peels coarse. Woolly in spots and fibres pick up badly. Numerous cracks causing short lengths. Useless for ply-wood."

(iii) To compare with *Grewia lilaefolia*, 5 logs of *Grewia vestita* were sent to the Forest Research Institute for testing under Project I from the Kurseong Forest division during 1931-35.

(iv) *Gmelina arborea*, 4.

Artocarpus chaplasha, 4.

Dipterocarpus spp., 4.

Michelia champaca, 4.

Sample logs of the above species were sent to the Dehra Dun Forest Research Institute from Chittagong Hill Tracts division during 1931-35 to test their quality with a view to the possibility of extending their use outside Bengal.

(ix) One log of each of the following species was sent to Messrs. C. Lazarus and Company, Calcutta, for test in the manufacture of furniture :—

From Kurseong division—

Chickrassy (*Chukrasia tabularis*).

Pakasaj (*Terminalia tomentosa*).

Chapalish (*Artocarpus chaplasha*).

From Sundarbans division—*Pussur* (*Carapa moluccensis*).

No report has yet been received.

(x) *Sonneratia apetala*.—Two *keora* (*Sonneratia apetala*) logs were supplied to Messrs. Mansfield & Sons, Calcutta, for test in heavy packing and turned out to be quite suitable for the purpose.

(xi) *Gmelina arborea*.—One sample piece of *gannari* (*Gmelina arborea*) was sent to Messrs. Chittaranjan Crochet Cotton Manufacturing Company, Calcutta, for testing in making reels, etc., from Kurseong division, but no report has yet been received.

(xii) *Terminalia tomentosa*.—One sample piece of laurel (*Terminalia tomentosa*) was sent to Messrs. Coondoo Paul & Coy., Calcutta, for test in the manufacture of wooden handles from Kurseong division, but no report has been received.

(xiii) *Michelia champaca*.—(a) Three specimens of *champ* (*Michelia champaca*) were sent to the Timber Adviser to the High Commissioner for India, London, for testing its suitability for making engineers patterns.

(b) *Alnus nepalensis*.—Arrangements are also being made to send 3 more specimens of *utis* (*Alnus nepalensis*) to the Timber Adviser to the High Commissioner for India, London, from India, for the same purpose.

(xiv) Logs of the following species were sent to Messrs. G. C. Law & Company, Calcutta, for testing their suitability in the manufacture of pencil and penholders :—

(1) Hill toon (<i>Cedrela microcarpa</i>)	•	•	•	•	•	From Kalimpong division.
(2) Lali (<i>Anoora wallichii</i>)	•	•	•	•	•	From Kurseong division
(3) Kainjal (<i>Bischofia javanica</i>)	•	•	•	•	•	Do.
(4) Gamari (<i>Gmelina arborea</i>)	•	•	•	•	•	Do.
(5) Toon (<i>Cedrela toona</i>)	•	•	•	•	•	Do.
(6) Mahogany (<i>Swietenia macrophylla</i>)	•	•	•	•	•	From Chittagong Hill Tracts.

(7) Malatta (<i>Macaranga denticulata</i>)	From Buxa division.
(8) Do. (<i>Macaranga indica</i>)	Do.
(9) Hatipauli (<i>Pterospermum acrifolium</i>)	Do
(10) Kawla (<i>Machilus gamblei</i>)	Do.
(11) Lasuno (<i>Amoora rohituka</i>)	Do.
(12) Champ (<i>Michelia champaca</i>)	Do.
(13) Ramgua (<i>Horsfieldia kingii</i>)	Do.
(14) Chowripatey (<i>Meliosma simplicifolia</i>)	Do.
(15) Mawa (<i>Engelhardtia spicata</i>)	Do.

Reports submitted by Messrs. G. C. Law & Co., Calcutta, on the above logs are given below:—

- (1) Kainjal (*Bischofia javanica*) :—Suitable for manufacture of pencils.
- (2) Lali (*Amoora ualichii*) :—Suitable for manufacture of penholders and pencils.
- (3) Gamari (*Gmelina arborea*) :—Unsuitable for the manufacture of pencils and penholders.
- (4) Hill toon (*Cedrela microcarpa*) :—Suitable for pencil making.
- (5) Mahogany (*Swietenia macrophylla*) :—Due to high price of the timber it cannot be used for the manufacture of pencils and penholders.
- (6) Toon (*Cedrela toone*) :—Suitable for pencil making.
- (7) Malatta (*Macaranga denticulata*) }
- (8) Hatipaili (*Pterospermum acrifolium*) }
- (9) Kawla (*Machilus gamblei*) }
- (10) Mawa (*Engelhardtia spicata*) } Not suitable for pencil or penholder manufacture.
- (11) Champ (*Michelia champaca*) }
- (12) Ramgua (*Horsfieldia kingii*) }
- (13) Chowripatey (*Meliosma simplicifolia*) } Good for both pencil and penholder making.
- (14) Lasuno (*Amoora rohituka*) }

(xv) Hand samples of the following species were sent to the Manager, Venesta Box Factory, Kamarkati, from Kurseong division, for testing the manufacture of making corner pieces of venesta tea boxes:—

1. Kadam (*Anthocephalus cadamba*).
2. Mainakat (*Tetrameles nudiflora*).
3. Pitali (*Trewia nudiflora*).
4. Chickrassy (*Chuckrasia tabularis*).
5. Chativan (*Alstonia scholaris*).

6. Kainjal (*Bischofia javanica*).
7. Plains kawla (*Machilus gamblei*).
8. Raktan (*Lophopetalum fimbriatum*).
9. Latikaram (*Hymenodictyon excelsum*).

No report has yet been received.

(xvi) *Shorea robusta*.—A comparative result of test on sal (*Shorea robusta*) from Sukna range of Kurseong division with sal from Kalimpong and Jalpaiguri divisions (one consignment) received from the Forest Research Institute, Dehra Dun, are given below :—

" Although in the green condition, Kurseong sal appears to be slightly superior to the other consignment, it has gone down in air-dry values showing poor improvement of strength due to seasoning. It has suffered considerably in sheer and tension in the radial directions. The ratio of tangential and radial shrinkage is also greater. All this points to a slightly greater tendency to split and check.

It saws and machines reasonably well and is suitable for the usual run of purposes for which sal is put although it may check slightly more than other sal."

(4) *Wood Preservation* :—Nil.

(5) *Minor Forest Produce*.

Gurjan oil.—(a) The tapping of gurjan oil departmentally has been abandoned.

(b) The results of the experiment on one pound of gurjan oil sent to Messrs. Johnson & Nicholson (India), Ltd., Calcutta, from Chittagong division during 1935-36 is not yet known.

(c) A sample tin of gurjan oil was also supplied to the Director of Industries, Bengal, from Chittagong division in 1933-34, for test as to its suitability for paint manufacture but no report has yet been received.

(d) Some seeds and roots of *Sapium indicum* were sent to the Bio-chemist, Forest Research Institute, Dehra Dun, for experiment as to whether it has the qualities of a fish poison.

(6) *Paper pulp*.

One ton of unbarked *gengwa* (*Excoecaria agallocha*) was sent to the Utilisation Officer, Forest Research Institute, Dehra Dun, for experimental work on the preparation of mechanical pulp, but no report has yet been received.

Bamboos.—A specimen of *Dendrocalamus hamiltoni* was sent from Kalimpong division to the Officer-in-charge, Commercial Museum of

the Corporation of Calcutta, for exhibition according to his request, and it is reported to have been highly admired.

Charcoal briquettes.—*Cryptomeria japonica* is unsatisfactory both for fuel and charcoal, owing to its habit of sparking. 9 maunds 35 seers of *Cryptomeria* charcoal were prepared and sent to Dehra Dun from Darjeeling division for test in making charcoal briquettes. If *Cryptomeria* charcoal can be used in the form of briquettes, which do not have a tendency to spark, it will materially increase the saleable value of the *Cryptomeria* fuel.

(7) *Tans* :—Nil.

(8) *Wood working.*

(i) A mature *timur* (*Zanthoxylum budrunga*) tree was felled and sawn up in the Buxa division for local experiment, as this timber was much used in the Dacca District for furniture making. The timber has not behaved well there, cracking and splitting badly even in the log when it was sawn.

(ii) No report on the specimens of *gurjan* (*Dipterocarpus turbinatus*) sent to the Ceylon Government Railways, Colombo, has yet been received.

(iii) Report on the specimens of *sal* (*Shorea robusta*) sleepers sent to Ceylon and the Sudan has not yet been received.

(iv) Specimens of the following were sent to the Utilisation Officer, Forest Research Institute, Dehra Dun, from Jalpaiguri division :—

Dalbergia sissoo . . . herbarium specimens.

Trewia nudiflora . . . fruit, leaf, and wood specimens.

(v) Some *Salix tetrasperma* was supplied to the Superintendent, Cordite Factory, Aruvankadu, for experiments.

(vi). Tali (*Diehopsis polyantha*) is abundant in Chittagong Hill Tracts division. It is required to test its strength to see if it could be substituted for imported oregon pine and if a market could be created for it. The Utilisation Officer, Forest Research Institute, Dehra Dun, says that the species has been added to their test programme and has asked for 5 logs to be sent for the purpose. Arrangements have been made to send the logs to Dehra Dun for testing.

(vii) The following samples of timbers were supplied from Kurseong division :—

(a) One piece of gamari (*Gmelina arborea*) scantling to Messrs. Chittaranjan Crochet Cotton Manufacturing Company, Calcutta.

(b) Two samples of chickrassy (*Chukrasia tabularis*) planks were sent to Mr. B. N. Ghosh, Government and Railway Contractor, Delhi.

(viii) Samples of laurel (*Terminalia tomentosa*) from Kalimpong division have been sent to railways and others, and it is hoped to be able to introduce it in the market.

(10) *Miscellaneous.*

(i) *Medicinal plants.*—Enquiries were made by Messrs. Birla Bros., Calcutta, regarding medicinal plants available in the Sinchal range (Darjeeling division) and they were informed that *Dyckroa febrifuga* plants were abundant, but no reply was received from the Company during the year under report.

(ii) *Introduction of silage feeding of cattle in the Hills.*—4 experimental silo-pits were constructed at Dilaram (Kurseong division), Suktiapokhri, Jorebunglow and Takdah (Darjeeling division) respectively. They were filled with fodder collected from our plantations. Grasses were collected in preference to other species with the object of making good silage.

The objects of this experiment are :—

- (a) To introduce the silage system to the local population and to encourage them to use this type of fodder when fodder is short during the dry season.
- (b) If this system is introduced successfully it should reduce lopping and cutting of prohibited species in the forest during the dry season by fodder cutters.
- (c) Another object in view is that if plantations are cut for fodder for the preparation of silage under departmental control, it will lessen the cutting of coppice and natural seedling recruitment in the plantations.

(iii) The usual liaison was maintained with the Divisional Forest Officers, Timber Advisory Officer to the Railway Board, Timber Adviser to the High Commissioner for India, London, and the Forest Research Institute, Dehra Dun.

General.

The Forest Utilisation Office is still of fairly recent origin in Calcutta having been established hardly 2 years back, but the increased calls and invitations received for technical advice and information more than justify the decision of transferring the Headquarters from Darjeeling to Calcutta.

A proposal for a joint bureau for controlling the sales and publicity of forest produce of several neighbouring provinces in Calcutta is under the consideration of Government.

Although the maximum possible timber out-turn of the province is not sold, the quantity of building material and soft wood that this province imports from foreign countries, including Burmah, is amazing.

Whether this is due to lack of facilities of extraction or transport or the unsuitability of indigenous wood, will have to be investigated. It is necessary to have a detailed survey made of the requirements of forest produce of the population of every district of Bengal, the source of their present supply, and the possibility of economic utilisation of the Province's produce to satisfy these requirements.

Calcutta is by far the most important timber market within the whole of India. As much as 8,000 cubic tons of timber were imported into Calcutta during the month of March 1938 by sea.

To achieve the desired result the establishment of up-to-date saw-mills for better conversion, and the introduction of seasoning kilns and impregnating plant for the improvement of our indigenous materials may be necessary. Legislation and the co-operation of the Railways and the Steamer Companies to transport our materials at competitive rates of freights, may also be necessary.

Negotiations on these lines with the authorities concerned have already been undertaken.

BIHAR.

I.—GENERAL WORK OF ADMINISTRATION.

The Forest Research Officer, and the Working Plans Officer held charge of the Utilization office during the year under review. The assistance of the Utilization Ranger was only available for a short time from July to December 1937, after which he was attached to the Working Plans office.

II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

Grading rules for timbers.—As reported last year, grading rules were printed, and complimentary copies were distributed to all engineering firms, principal contractors and consumers of the Province, and to Utilisation Officers of other provinces. Extra copies on payment were asked for and supplied to several Divisional Forest Officers in the Central Provinces, Bombay and Madras.

Railway freight.—As a result of representation to the Superintendent, Rates and Development, as outlined in last year's report, success was achieved in getting the freight rates for charcoal from exporting stations of Singhbhum District reduced, with effect from 1st January 1938.

Publicity and propaganda.—Several enquiries were made for Indian Forest Record, Vol. XVIII, Part X, "Physical and Mechanical Properties of Woods grown in India", and these were forwarded to the Forest Research Institute. A few extract reprints were issued free to Public Works Department Chief and Superintending Engineers. As mentioned last year, the four utilisation posters from the Forest Research Institute were converted to linen backed pictures and distributed to all Engineers, District Magistrates, Engineering Colleges and firms, Divisional Forest Officers and Range Officers.

Besides this, pictorial postcards entitled "What does the future require of you" and "Save your forests and prevent desolation", showing pictures of first quality sal alongside eroded country, were also widely distributed.

Exhibitions.—Due to lack of funds and insufficiency of staff, the Department could not participate in the provincial exhibition at Patna.

Khunti exhibition in Ranchi District.—We were invited to participate in the second annual exhibition of agricultural products at Khunti, held in January 1938. Wood samples and minor forest products and several forest pictures and posters were sent to the exhibition held there under the supervision of the officiating silvicultural Forester. The exhibits were well displayed in the lecture hall of the Middle English School alongside the exhibition ground. Mr. J. N. Sinha, E.A.C.F., also delivered two lectures in English and on the third evening officiating Forester M. Bodra, delivered one in Uraon. The lectures were much appreciated. We have now a good collection of two hundred and eighteen slides as subject material for lectures.

A certificate of merit was awarded by the Managing Committee of the exhibition.

Ranchi exhibition.—On return from Khunti, all the exhibits, plus others from the head office, were exhibited in Ranchi Gait Park in a swiss cottage tent. Several boxes of seedling plants were also exhibited and some were sold.

Santal Parganas exhibition.—The Divisional Forest Officer, Santal Parganas, again requested for exhibits for the Hizla mela, but owing to the short notice given none could be sent.

All-India fibre exhibition at Calcutta.—Exhibits of rope made of sabai grass (*Polliniidium angustifolium*) and *Bauhinia vahlii* creeper were sent to this exhibition held on the 15th March 1938.

Picture frames with celluloid fronts for grouping full size photos on Wood Preservation, Reclamation, Grazing, Erosion and Denudation, Transport, and Seasoning of Timbers have been made. More groups are to be framed this year. These pictures will be invaluable for educational purposes at exhibitions,

Experience has shown, and is showing ever more clearly, that propaganda and education of the general public, and of the engineers of the Province, in forest matters, is one of the main duties of the Utilisation office. During Mr. Kamesam's hurried visit in July 1936, one engineer confessed that "We engineers know little about the value and strength of timbers and have few books to guide us".

Since then much has been done to improve the position by getting the Forest Research Institute to send appropriate literature sometimes free, sometimes on purchase, while the Institute's posters are now in the hands of all engineers. But in order to keep engineers abreast of current thought and practice in timber engineering they should receive regular supplies of current literature. One of the most effective ways of doing this is to circulate to them monthly timber periodicals.

From the monthly bibliography of the Imperial Forest Institute, Oxford, two periodicals have recently been selected, one American, the other British, which practically cover the whole ground of timber engineering activity. Copies of these periodicals have already been circulated to the Chief and Superintending Engineers and have been very favourably received. Cyclostyled copies of summaries of the more important issues have also been sent to all Executive and District Engineers, and these have evoked immediate requests from several for the favour of receiving the magazine itself for perusal. The Superintending Engineer of Bhagalpur especially wished to circulate copies to all his Executive and District Engineers. It is impossible for one single copy of each magazine to do service for all engineers. Besides this, Divisional Forest Officers ought to keep abreast of the times.

To organise this education in timber matters effectively, six copies of each magazine monthly, are required. The cost would be about Rs. 170-0-0 annually. Two other books obtained with the help of the bibliography, namely Timber Connectors and a wood preserving pamphlet showing how concrete roadways are attached to the timber substructure, were also circulated to engineers, but each engineer should have his own copies.

The annual limit of Rs. 300-0-0 for periodicals in the whole circle was never intended to meet a situation such as this. At present, in order that engineers shall receive even the one circulated copy, money badly needed for other forest periodicals has to be curtailed. Government have been approached to increase the grant to Rs. 600-0-0.

Much work on propaganda was done during the year, and valuable information from pamphlets and periodicals was brought home to engineers through cyclostyled copies.

The proposal for erecting an Ascu treated bridge over the Subarnarekha river on the Piska-Daladali road, by the District Engineer of

Ranchi, may perhaps be attributed to the result of this propaganda. The total cost f.o.r. Ranchi, for treated sawn timber was estimated to be Rs. 2-11-9 per c. ft.

Summary of Results.—In pursuance of the Utilization policy, the Forest Research Officer surveyed inland and foreign markets for established contact between consumers and suppliers of forest produce.

Two trial wagon loads of gumhar (*Gmelina arborea*) and chilbil (*Holoptelea integrifolia*) in 8", 10", and 12" squares, have been arranged with a contractor for testing as a moulding wood. The consignment is expected to be despatched by June 1938.

The visit of Mr. Trotter, Forest Utilisation Officer of the Research Institute, at the end of January 1938, has stimulated interest in Bihar timbers. The suggestion that pre-fabricated Ascu treated sal might be used for the erection of coolie huts is being followed up.

Principal, Indian School of Mines, Dhanbad.—This Institute requires woods for furniture making. Samples of *Pterocarpus marsupium*, *Albizia procera*, *Terminalia tomentosa*, *Gmelina arborea*, *Hymenodictyon excelsum*, and *Holoptelea integrifolia* were sent for his approval. He subsequently placed orders for well-seasoned pieces.

Samples of sixteen commercial timbers were made and supplied to the Orissa States Forest School with a short description of their uses, weight in lbs. per c. ft. at 12 per cent. moisture content, and approximate annual yield.

General Engineering Company, Gaya.—As a result of supplying posters to this firm, we were requested to arrange for a supply of treated wood for constructional purposes.

Gun stocks.—Samples of safed siris (*Albizia procera*) were supplied from Palamau to Messrs. Mullick & Co., Patna, for testing as gun stocks. They reported that the sample was cracked, otherwise it was quite suitable. The cracking was attributed to that particular specimen being unseasoned when supplied. 36 *Albizia procera* planks in sizes varying from 6' × 18" × 6" to 8' × 6" × 1½" are now being seasoned in the Chippadolar seasoning shed since March last. Samples of 6" thick planks will be sent for trial after 18 months' seasoning, and the 1½" thick plank after the rains.

Tool handles.—Babu Tarapado Bose, well versed in mechanical engineering, has been given a lease in Singhbhum for *dhaura* (*Anogeissus latifolia*) with option of also taking *karam* (*Adina cordifolia*), *arjun* (*Terminalia arjuna*), *amsabita* (*Mitragyna parvifolia*), *safed siris* (*Albizia procera*), *kendu* (*Diospyros melanoxylon*), *sidha* (*Lagerstroemia*

parviflora) on a royalty basis. 26 dhaura (*Anogeissus latifolia*) and 24 trees of other species have been felled by him and he is now seasoning the converted material at Chakradharpur. His machinery has arrived and he is busy erecting it. He hopes to extract to Chakradharpur by petrol lorry as this is considerably cheaper than railway freight *plus* double handling charges.

As mentioned last year, we are still awaiting samples of tool handles from the Forest Research Institute made of kendu (*Diospyros melanoxylon*), sidha (*Lagerstrænia parviflora*), dhaura (*Anogeissus latifolia*), kusum (*Schleichera trijuga*), asan (*Terminalia tomentosa*), and dhaman (*Grewia tiliaefolia*). These are to be sent as soon as the wood is seasoned.

Match woods.—Several enquiries for woods suitable for match manufacture were received during the year. Salai (*Boswellia serrata*), char (*Buchanania latifolia*), simul (*Bombax malabaricum*) and amra (*Spondias mangifera*) are the commonest species in this Province.

A definite order for 1 ton *Boswellia serrata* a day is expected from Messrs. B. C. Roy & Co., Ranchi, but our supplies of match wood species are too limited, and it is doubtful if the full requirements can be met. However, the question of enumeration of salai (*Boswellia serrata*) in Palamau division is under consideration.

Boxwood species.—Our supplies of boxwoods are far too small to meet the demands of enquirers.

Foreign market.—An enquiry from the High Commissioner for India has been received for sending samples in 12" × 6" × 3" sizes of species suitable to replace *Alstonia* for pattern making. Samples of nine different species were sent, three of them being better than *Alstonia* itself. We are hopeful of receiving an order.

Electrical poles.—240 light transmission poles, of 300 lb. carrying capacity, were supplied to the Darbhanga-Laheriasarai scheme (65), the Ranchi extension scheme (25), and to the Berhampur Electrical Supply Company (150), for which a royalty of Rs. 6-0-0 per pole, less 5 per cent. commission to this office, was received by Divisional Forest Officers.

Bihar grid scheme.—Acting on press reports, enquiries to the Electrical Inspector elicited the information that at least 10,000 poles would be required. Government were notified that if orders were to be placed with us, at least 18 months notice should be given for collecting, partly seasoning, impregnating and again seasoning the poles. The Special Officer now in charge of the scheme was advised that a special rate of 0-12-9 per c. ft. for impregnation would be quoted to Government by Callender's for any poles required for that scheme, which means that the 300 lb. class pole of 30' length would cost about Rs. 13-0-0 and the cost of 500 lb. pole of 36' would be Rs. 16-0-0 or Rs. 17-0-0.

(1) *Wood technology*.—Nil.

(2) *Timber seasoning*.—A second seasoning shed has been constructed at Goilkera, with 8 stack capacity, for Rs. 840-0-0. The first seasoning shed at Chippadohar is already in use for supplying Messrs. Tatas with moulding woods of *chilbil* (*Holoptelea integrifolia*) and *gumhar* (*Gmelina arborea*).

(3) *Timber testing*.—Nil.

(4) *Wood Preservation*.—The Ascu plant has been finally installed at Goilkera as the most convenient centre for the Singblum forests. More than 600 poles have been impregnated in this plant and 240 have been sold.

(5) *Minor Forest Produce—medicinal plants*.—Several enquiries for a list of medicinal herbs and plants were received during the year. A booklet giving botanical and vernacular names of all medicinal plants and herbs found in the forests of Bihar and Orissa is under compilation. This will be printed and circulated to all Pharmaceutical Institutions.

(6) *Grass*.—The Talchar *sabai* grass factory has sent samples of mats weaved with *sabai* grass (*Pollinidium angustifolium*) to a firm in England, from samples supplied by the Forest Department. These have been appreciated. The firm's requirements are for mats in 40 yards lengths, in widths of 12", 24" or 36".

(9) *Hay*.—Results of analysis of grasses, sent from Phulmanu division to the Agricultural Chemist, Sabour, are given below.

Serial No	Lab. No.	Bihar Office No.	Name of the grass.	CHINNOOL COMPOSITION FACTOR ON OWN DRY MATTER.						DIGESTIVE CONSTITUENTS.				
				Moisture.	Nitrogen.	A.t.h.	Ether extract.	Crude protein	Crude fibre.	N. free extr. including carbohydrate.	Crude protein.	Crude fibre.	N. free extr. including carbohydrate.	
1	F. ₁₀	1	<i>Chrysopogon tenuis.</i>	8.66	0.72	0.6	1.80	4.48	26.48	57.0	0.93	2.24	14.66	
2	F. ₁₀	3	<i>Rottboellia exaltata</i>	0.22	0.84	10.3	0.80	6.25	31.13	52.0	0.40	2.62	17.12	
3	F. ₁₀	4	<i>Apiaze articata</i> , Ichn.	•	8.47	1.11	8.13	1.30	7.00	23.27	56.3	0.65	3.5	15.55
4	F. ₁₀	5	<i>Schizachyrium heteroleucon</i> , Nees.	9.14	0.75	12.10	1.60	4.98	20.11	55.7	0.70	2.34	14.36	32.86
5	F. ₁₀	0	<i>Amphibolus nubera</i> , Stapf, var glabra.	6.24	0.01	8.18	2.22	6.05	22.8	60.0	1.11	2.82	12.54	35.03
6	F. ₁₀	7	<i>Ophiurus burmannii</i> , Deless.	7.17	2.10	14.01	1.35	13.13	20.70	40.9	0.67	6.56	11.30	20.14

All these grasses possess good fodder value. F.₁₀ is better than others. They are as good as elephant grass (green).

(11) *Miscellaneous.—Floating, Chaibassa division.*—Attempts are being made to make the Roro river floatable for the 12-14 miles stretch from the Protected Forest 30 to Chaibassa. Four floats of *salai* were made at Roro, and a raft of 10 poles of 30'-32' length was tied to them for experimental floating. Several sharp bends in the river were met with, which could not be negotiated by such long poles, and it was found necessary to cut them in two. The raft reached Chaibassa the following day. If floating is to become feasible, the curves in the river must be widened, the rapids must be cleared, and launching must be delayed until there is a suitable height of water. The river has since been treated as far as Barabassa near Baipi, and 200 sal poles have been stacked ready for further trials this year. The total expenditure incurred was Rs. 299-0-0.

CENTRAL PROVINCES AND BERAR.

GENERAL.

This part deals with the experimental work connected with the utilization and marketing of forest products, and the general commercial activities of the Forest department. The work is in charge of the Forest Utilization Officer, Khan Sahib Abdus Salam, Extra Assistant Conservator of Forests, who held charge of the post throughout the year under report.

EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

New markets for electric transmission poles of teak and *Polyalthia cerasioides* were opened up during the year.

Saw Mill.—The Allapilli Saw Mill turned out 81,442 (66,560) cubic feet of sawn timber. The sales compared as under:—

	Quantity.	Amount.		
			C. ft.	Rs.
Logs	177,440 (165,031)	2,32,443 (1,03,123)		
Sawn timber	78,340 (70,111)	1,32,012 (1,10,849)		
			.	
TOTAL	255,780 (225,741)	3,64,455 (3,12,972)		

The details are given below :—

(1) *Logs.*

Kind of produce.	Class	Quantity.	Amount	Average rate per c. ft
				c. ft
Teak logs	1	732	1,840	2 8 3
Do	2A	78,608	1,24,101	1 0 3
Do	2B	71,106	69,072	1 4 1
Rough squared Alm (1) . . . . .	..	10,191	7,144	0 11 3
Shisham (2) . . . . .	..	3,587	2,643	0 11 2
Haldia (1) . . . . .	..	3,060	2,441	0 12 0
Gurara poles (4) . . . . .	..	4,155	1,060	0 4 1
Teak poles . . . . .	..	6,406	8,826	0 11 2
Suriya poles (5) . . . . .	..	303	303	1 0 0
It Lee Bamboos . . . . .	..	1,000	6	..
Total		175,410	2,12,441	..

- (1) *Terminalia tintenaria*
- (2) *Dillingeria latifolia*
- (3) *Adenanthera cordifolia*
- (4) *Cleistocalyx collinus*
- (5) *Xylosteum zizocarpum*

(2) *Sawn Timber.*

Kind of produce.	Class	Quantity.	Amount	Average rate per c. ft
				c. ft.
<i>Standard sizes.</i>				
Teak scantlings	1	15,734	35,736	2 4 4
Do	2	25,297	45,448	1 12 6
Do	3	10,417	16,661	1 7 2
Teak battens	1	2,039	3,170	1 8 0
Do	2	6,425	6,783	1 4 0
Do	3	4,530	4,700	1 0 10
Planks	1	3,406	10,749	3 2 6
Slabs	1	165	42	2 0 5
Ceiling planks	1	16	49	3 0 10
<i>Undersizes and Mill waste</i>				
Teak scantlings . . . . .	..	6,752	6,595	0 15 8
Teak battens . . . . .	..	4,116	2,786	0 10 10
Teak planks . . . . .	..	440	760	1 11 6
Other species . . . . .	..	1	1	1 7 0
Total		78,347	1,32,013	..

Sleepers.—This was the second year of the three-year contract and no difficulty was experienced in complying with the indent. A larger number of contracts was undertaken during the year and receipts compare as under :—

Contracts undertaken	25 (14)
Number of sleepers	95,167 (90,051)
Value	Rs. 2,40,220 (2,00,789)

Hand Sawing—Sal.—The hand sawing of surplus timber into small dimension stocks was continued in all the sal divisions. The quantity turned out during the year was 87,849 c. ft. (90,769 c. ft.).

Teak.—Hand sawing in the Bori coupes was continued, and 22,076 c. ft. of small sizes were sawn and sent to Taku depot. The market for this timber continued to be good. Similar operations were also revived in western Hoshangabad and the material fetched good prices.

Experimental sawing of logs into squares at Ellichpur depot proved successful and encouraging prices were received.

Paper Pulp.—The firm of Messrs. Narrondas Mannordas of Bombay are examining the possibilities of erecting a pulp factory utilizing *Dendrocalamus strictus* as its raw material and the vicinity of Chanda has been suggested as a possible site, in view of the fact that the essential conditions as regards water, lime, coal, power, adequate raw material, labour, land, etc., appear to be fulfilled. As both Chanda and Ballarshah are on the broad gauge railway the necessary chemicals can also easily be imported via Calcutta, Madras or Bombay, and the export of the manufactured pulp and paper will also be equally easy. Representatives of the firm visited Ballarshah in January and appear to have been satisfied with regard to the suitability of the site. A rough trace of the forest areas has been supplied to them to facilitate a survey of the areas under bamboo, for which work the services of an experienced Ranger is to be placed at their disposal free of charge.

Plywood.—A representative of a Delhi firm has shown a desire to erect a plywood factory for the utilization of *salai* (*Boswellia serrata*). A possible site near Khirkiya on the G. I. P. Railway has been suggested as the result of an interview of the interested party with the Chief Conservator of Forests, C. P., and the Inspector General of Forests. Preliminary information required by the firm regarding the supply of raw material is being collected from Nimar, Melghat, Hoshangabad and Betul divisions, and the utilization of *laurel* (*Terminalia tomentosa*) and *haldū* (*Adina cordifolia*) has also been suggested.

Match Industry.—The Chanda Match Works continued to work throughout the year. The factory turns out 100 grosses of match boxes a day. The *semal* of North Chanda division supplied at concessional

rates is not found to be satisfactory for splints owing to its brittleness and brownish colour. The Manager is prepared to try other soft wood species but these are not available in commercial quantities. The Silviculturist was consulted, and his suggestion to experiment with *Hymenodictyon excelsum* as also to colour the splints has been tried with satisfactory results.

Gun Carriage Factory.—One order for 3,195 cubic feet of sal logs valued at Rs. 3,738 was undertaken during the year and supplied from Mandla, Balaghat and Raipur divisions, and another for sawn teak worth Rs. 764 was supplied from South Chanda division.

MISCELLANEOUS TIMBERS.

Garari (Cleistanthus collinus).—The demand for poles of this species was steady, 3 orders for 2,100 poles were undertaken and supplied from South Chanda division. Efforts to develop the market were continued.

Gardenia latifolia.—One wagon load of this wood from North Chanda division was supplied to a cabinet making firm in Navsari.

Haldu (Adina cordifolia).—Orders to the extent of 1,200 cubic feet of this timber were undertaken during the year and supplied from South Chanda division. Demand for this species continued on a limited scale.

Maida lakri (Litssea sebifera).—The sale of this species in the Chhindwara division realised Rs. 45 against Rs. 20 in the previous year.

Polyalthia cerasoides.—A new market for the poles of this species was created during the year and negotiations for placing orders were in progress. The demand is sure to increase if supplies are possible.

Saja (Terminalia tomentosa).—286 cubic feet of this species were collected and sold by auctions at Khirkiya. Orders for rough squared logs to the extent of 1,500 cubic feet were undertaken and supplied from South Chanda.

Salai (Boswellia serrata).—A firm in Bombay was supplied with samples of salai wood from Nimar.

Semal (Bombax malabaricum).—The auction sales of this wood fetched better prices, giving an average of Rs. 9-14-7 per tree as compared with Rs. 7-9-9 in the previous year.

Suriya (Xylia xylocarpa).—A wagon load of this timber was supplied to the Nizam's State Railway from South Chanda division.

Tinsa (Ougeinia dalbergioides).—There was a good demand for this timber, and 7,012 cubic feet collected at Taku depot during the year were sold readily. Small quantities of poles were collected in rough squared form at Ellichpur depot and were sold by auction at satisfactory prices.

Pit-props.—Orders for pit-props amounting to Rs. 10,520 were secured from various collieries during the year and supplied from Hoshangabad, Mandla, Balaghat and Chanda division. The demand for pit-props of sal has fallen off as this species is said to deteriorate rapidly.

Electric transmission poles.—A new business was developed by opening up a market for long teak poles. An order from Messrs. Callenders' Cable Construction & Co. Limited, of Bombay, was undertaken, and 383 poles supplied at Itarsi before the close of the year. Small quantities were also collected at Ellichpur and Khirkiya depots and disposed of by auction. The following table shows the number of poles handled during the year and the amount realised :—

Depots.	No. of poles.	Quantity c. ft.	Revenue realised.
Ellichpur	79	406	Rs. 425
Khirkiya	95	..	342
Itarsi	383	2,585	3,181
TOTAL .	557	..	3,947

Charcoal.—The charcoal industry is making headway throughout the province. To encourage the use of "Frikilns" (a kiln invented at Dehra Dun for dry conversion of wood into charcoal), several merchants were persuaded to make trials. So far, only two of them have obtained drawings with a view to have the kilns made locally. To give an impetus to the industry, the department is getting a 'Frikiln' made locally for demonstrating its use to the students at the Forest School, Balaghat, and to the public.

Bamboos.—The departmental exploitation of bamboos was continued in Kota, Sonakan and South Loan, ranges of Bilaspur division, and a revenue of Rs. 34,827 (23,310) was realised.

TIMBER TESTING.

Samples of *Zizyphus jujuba*, *Zizyphus xylopyrus* and *Zizyphus rugosa* from Melghat and Nimar divisions have been supplied to the Timber Adviser to the High Commissioner for India for trial. The charcoal of these species is required for making gun powder. The results of the trials are not yet known.

Gardenia latifolia.—The Linen Industry Research Association, Research Institute, Lambeg, Antrim, Ireland, is in search of a substitute for boxwood for spinning rollers. *Gardenia latifolia* has been suggested by the Forest Research Institute. Four small samples were kiln seasoned at the Gun Carriage Factory, Jubbulpore, and supplied to the Director of the Association. Results of the tests are awaited.

Salai (Boswellia serrata).—Four logs of this species are being supplied from Nimir division to the Research Institute, Dehra Dun, for testing the suitability of this wood for veneers. The collection of the logs was in hand at the close of the year.

Minor Forest Produce.—Lac.—The amount of lac collected during the year is given below :—

	Division.	Quantity.	Mds.
Saugor	.	1,204 (848)	
Damoh	.	2,953 (1,893)	
Bilaspur	.	30 (nil)	
Balaghat	.	nil (26)	
Jubbulpore	.	150 (62)	
Raipur	.	143 (203)	
Sconi	.	347 (284)	
Bhandara	.	438 (250)	
Hoshangabad	.	67 (63)	
Chhindwara	.	3 (nil)	
TOTAL	.	5,344 (3,689)	

The collection shows 50 per cent. increase in quantity but the receipts fell owing to a drop in the T. N. price from Rs. 24 to Rs. 15-8-0 per maund during the year. The revenue realised is detailed below :—

	Circles.	Revenue.	
			Rs.
Eastern	.	30,460 (31,620)	
Central	.	4,805 (4,714)	
Western	.	66 (689)	
Total	.	35,131 (37,032)	

Rusa grass.—The demand showed a slight improvement as a result of which the leases fetched Rs. 5,319 as against Rs. 2,100 last year.

Kulu gum.—The demand for gum *karaya* from *Sterculia urens* was good but prices were low. The following quantities were exported from Bombay Port to various foreign markets during the year :—

Exported to—	Cwt.
United Kingdom	1,173
Aden and Dependencies	4
Germany	20,703
France	2,037
Belgium	201
Netherlands	7,063
U. S. A. via Atlantic coast	35,685
TOTAL	75,969

An investigation started by the Silviculturist during the year to determine the best method of tapping the tree is described in the Silviculture portion of this report.

Departmental collection was continued in Saugor division which now includes Damoh also. Tapping on a small scale was undertaken in Nagpur-Wardha, Nimar, North Chanda, Jubbulpore, Bilaspur and Amraoti divisions.

Revenue realised from sales of the gum was :—

	Rs.
Eastern Circle	9,710 (12,357)
Central Circle	30 (500)
Western Circle	418 (nil)
TOTAL	10,167 (12,956)

Katha.—The demand for the manufacture of *katha* appreciated, and leases were sold in most divisions of the Eastern and Central Circles. Illohangabud division in the Western Circle showed a marked improvement in receipts. Rs. 5,651 were realised as against Rs. 100 in the previous year. Total revenue from this source was as under :—

Circle.	Revenue. Rs.
Eastern	11,180 (11,756)
Central	3,800 (1,000)
Western	5,651 (nil)
TOTAL	20,631 (12,756)

Leaves.—The *bidi* industry in the province is on the rise. The demand for *tendu* (*Diospyros melanoxylon*) leaves continued to be good

throughout the year and resulted in better sales of the leases. A lease for collecting the leaves was sold for the first time in West Berar division. Total receipts were as under :—

Circle.	Revenue.						
	Rs.						
Eastern							6,717 (5,202)
Central							52,330 (56,135)
Western							6,104 (1,893)
							<hr/>
							TOTAL . . 65,160 (63,322)

Fruits and seeds.—Revenue realised from the sales of miscellaneous fruits and seeds was Rs. 7,468 (Rs. 18,701).

Grasses.—*Sabai* grass was sold by annual leases realizing a revenue of Rs. 1,266 against Rs. 1,313 in the previous year.

Harra (Myrabolans).—The prevailing prices were as under :—

Particulars	March	March	July	Sept	Dec	March
	1936.	1937.	1937	1937	1937	1938
	RS A P	RS A P	RS A P	RS A P	RS A P	RS A P
Jubbulpore average . . .	1 1 0	1 11 0	1 7 0	1 12 0	1 14 0	1 6 0
Jubbulpore No. 1 . . .	1 6 0	1 14 0	1 14 0	2 4 0	2 12 0	1 12 0
Crushed No 1 . . .	2 0 0	3 2 0	3 2 0	3 2 0	3 12 0	3 4 0

Exports to foreign markets from Bombay Port during the past 3 years were as under :—

Year.	Quantity.						
	Cwt.						
1935-36							771,408
1936-37							545,553
1937-38							560,072

The contract for the Balaghat division was sold for a period of 3 years. This change was well received by the contractors and resulted in better revenue. Revenue realised from this source during the year was :—

Circle.	Revenue.						
	Rs.						
Eastern							22,496 (6,485)
Central							1,158 (335)
Western							618 (nil)
							<hr/>
							TOTAL . . 24,272 (6,820)

MISCELLANEOUS.

Lorry transport.—The Allapilli Timber Transport Company worked satisfactorily throughout the year. It transported from Allapilli to Ballarshah—a distance of 62 miles—260,963 (219,695) cubic feet of timber during the year.

Mechanical transport is gradually but steadily increasing amongst contractors. Five private lorries in Balaghat, two in the Melghat, one in Hoshangabad and two in Nagpur-Wardha divisions, were employed for transport of sleepers, timber, bamboos and charcoal from forest to rail-head at the ordinary cart wages paid by the department or by forest contractors. This is a healthy sign, and it is expected that in due course the people of the province will learn to undertake bigger ventures.

Railway concession.—As Taku, Tinarni and Khirkiya depots are being visited by merchants from distant markets of Northern India and Central India, the Railway authorities have been approached to consider the possibilities of stopping Mail and Express trains at these stations.

Lahore exhibition.—One merchant of Lahore exhibited at his own expense furniture made from Allapilli teak at the Lahore Exhibition held in 1938.

All-India fibre exhibition, Calcutta.—Specimens of fibre of the following species were supplied to the Commercial Museum, Calcutta, from various divisions for the All-India fibre exhibition held at Calcutta in 1938 :—

Bauhinia malabarica, *B. racemosa*, *B. vahlii*, *Butea frondosa*, *Careya arborea*, *Ficus bengalensis*, *Grewia hirsuta*, *G. tiliifolia*, *Heliocetes isora*, *Hymenodictyon ceculatum*, *Kydia calycina*, *Ougenia dulbergioides*, *Phoenix acaulis*, *Pollinidium binatum* (*Ischemum angustifolium*), *Sterculia urens*, *S. villosa*, and *Thespesia lampas*.

MADRAS.

I.—GENERAL WORK OF ADMINISTRATION.

The Forest Utilization Officer continued to be in charge of the work connected with the utilization of forest produce and studying market conditions, attending to research and propaganda. He also looked after the organisation and supply of track and special-sized sleepers to the Railway and of timber supplies to Government departments and other special markets.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

(1) *Sleepers*.—Joint annual inspections with railway officers of the experimental treated and untreated and test length sleepers laid in the several section of the South Indian Railway and M. and S. M. Railway, were made as usual. The species inspected were :—

<i>Dipterocarpus indicus.</i>	Treated.
<i>Cullenia excelsa.</i>	
<i>Eugenia gardneri.</i>	
<i>Paxiloneuron indicum.</i>	
<i>Paxiloneuron indicum.</i>	
<i>Eugenia gardneri.</i>	Untreated.
<i>Dalbergia latifolia.</i>	
<i>Hopca parviflora.</i>	
<i>Mesua ferrea.</i>	
<i>Xylia xylocarpa.</i>	

The inspection of *Hardwickia binata* sleepers laid in the Godavari district had to be postponed for want of time.

(2) *Wood preservation*.—The question of the supply of Ascu treated wooden poles to the Electricity Department was investigated. Definite action has not yet been taken though proposals have been made to Government for the installation of an Ascu or Creosoting plant, and Government orders are awaited. In the meantime arrangements have been made to supply untreated teak and miscellaneous hardwood poles to the Electricity Department.

(3) *Osmose wood preservative*.—The Kodaikanal Municipality have purchased and erected transmission poles of *Pinus insignis* treated with Osmose preservative in Kodaikanal, and the results have to be watched.

(4) *Timber seasoning*.—The question of proper seasoning of hardwood sleepers has again been taken up by the Department, and it is proposed to start an experiment on the lines indicated by the Forest Research Institute, Dehra Dun.

(5) *Strength tests*.—The results of strength tests on pine poles sent from the Kodaikanal plantations, Madura division, have not yet been received from the Forest Research Institute, Dehra Dun.

The report of strength tests of *Palmyra* poles sent from Cuddapah North has been received. The results indicate that *Palmyra* poles are suitable for electric transmission poles and are about equal to sal poles in the matter of strength.

(6) *Paper pulp*—*Botha* grass (*Cymbopogon coloratus*).—The semi-commercial tests made at the Forest Research Institute, Dehra Dun, on the suitability of *botha* grass for paper pulp indicate that this is suitable for the production of cheap grades of paper with an admixture of a percentage (about 25 per cent.) of some long-fibred pulp such as that of bamboo.

(7) Statistics regarding the approximate quantity of bamboos and grasses available in the forest divisions of this Presidency were collected and submitted to the Chief Conservator of Forests, for communication to the Forest Research Institute, Dehra Dun.

(8) With a view to find out the importance of growth rings in grading and utilization of timbers, teak logs from thinnings from Amarampalai range, Nilambur division, were sent for test to the Forest Research Institute, Dehra Dun. The first consignment was lost by the Railway. Another consignment is now being sent.

(9) Authentic specimens of wood, and botanical specimens of various timbers required by the Forest Research Institute, Dehra Dun, are being sent to the Forest Research Institute.

(10) *Wood working*.—(a) *Shuttles*: With a view to find out timbers suitable for shuttle manufacture, arrangements have been made for the supply of *Mesua ferrea*, *Hopea parviflora*, *Anogeissus latifolia*, *Pterospermum rubiginosum*, *Paciloneuron indicum* and *Hardwickia binata*, for test at the Forest Research Institute, Dehra Dun.

(b) *Timber resistant to teredo attack for harbour works*: Supplies of *Bischofia javanica* from Mangalore North division have been made for practical tests in the Vizagapatam, Madras and Cochin Harbour works, in order to test their power of resistance to the teredo borer.

(c) *Drawing boards*.—Samples of *Canarium strictum*, *Lophopetalum wightianum* and *Hymenodictyon excelsum* were sent to Messrs. Barton and Co., Bangalore, for test, but the firm has stated that they were not suitable for making drawing boards.

(d) *Motor bus bodies*.—The Joint Timber Advisory Officer, New Delhi, was interested in the use of possible substitutes for *Dalbergia sissoo* in motor lorries. The names of timbers used by the local firms, viz., bent teak (*Lagerstroemia lanceolata*) for bottom frames and bodies, *Bombax malabaricum* for roofing (covered with galvanised iron) teak and white cedar (*Dysoxylum malabaricum*), were communicated to him.

(e) *Match manufacture*—*Evolia roxburghiana* was reported by the Western India Match Co. as being good for splints; *Ailanthus malabarica* is also very useful in match manufacture, but supplies of *Ailanthus* are reported to be scarce,

(f) *Wooden handles*.—Messrs. Coondoo Paul and Co., Calcutta, were interested in *Grewia tiliacolia* for the manufacture of tool handles. This firm was supplied with samples from the Nilgiris division, and their report is awaited.

(g) *Novelty brush backs*.—Samples of figured teak, rosewood, poon, laurel, glutta, red sanders, pali and sandalwood are being sent to the Indian Trade Commissioner, U. S. A., Calcutta, in response to an enquiry forwarded by the President, Forest Research Institute, Dehra Dun.

(h) *Pencil manufacture*.—Small samples of the following timbers were supplied to the Madras Pencil Factory for test as possible pencil woods :—

1. <i>Holigarna armottiana</i> .	11. <i>Callitris rhomboidea</i> .
2. <i>Premna tomentosa</i> .	12. <i>Swietenia macrophylla</i> .
3. <i>Trewia nudiflora</i> .	13. <i>Pinus insignis</i> .
4. <i>Bombax malabaricum</i> .	14. <i>Pinus attenuata</i> .
5. <i>Sterculia urens</i> .	15. <i>Pinus maritima</i>
6. <i>Hymenodictyon excelsum</i> .	16. <i>Pinus ponderosa</i>
7. <i>Pterospermum rubiginosum</i> .	17. <i>Cedrela odorata</i> .
8. <i>Spondias mangifera</i> .	18. <i>Eugenia alternifolia</i> .
9. <i>Ilex wightiana</i> .	19. <i>Cedrela toona</i> .
10. <i>Salix tetrasperma</i> .	

} Results awaited.

The firm reported that none of them is suitable except the last five on which tests have not been completed.

Timber Testing.

(11) *Special tests on deep beam designs*.—Teak B. G. sleepers required for special tests on deep beam designs in the Forest Research Institute, Dehra Dun, are being supplied from the Nilambur division.

(12) *Strength tests*.—*Casuarina* poles for electric transmission lines will shortly be supplied to Dehra Dun forest, from the Nellore division.

(13) A sample of hammer handle was sent to the Forest Research Institute, Dehra Dun, by Messrs. Curzon and Co., Madras. On examination by the Wood Technologist, Dehra Dun, it was found to be made of *Atalantia* species. Botanical specimens of the woods are required by the Forest Research Institute to confirm this identification. It is reported that the handles tested have given very promising results and are comparable with hickory.

The identification has not been confirmed as yet. A sample of wood reported to bear a resemblance to this piece was sent to Dehra Dun but it was not the correct timber. Further attempts are being made to find the right species.

Commercial activities.

(14) *Track sleepers.*—30,000 B. G. and 17,000 M. G. hardwood sleepers were supplied to the South Indian Railway at the rate of Rs. 6 per B. G. and Rs. 2-12-0 per M. G. affording a revenue of about Rs. 2,26,750.

(15) *Teak special sized sleepers.*—The contract for the supply of teak special sized sleepers was renewed by the South Indian Railway for another two years from April 1937, and 17,038 sleepers affording a revenue of Rs. 1,73,283-0-0 were supplied during the year.

(16) *Timber Market.*—The results of auction sales held by the District Forest Officers in the Wynnaad, Coimbatore South, and Nilambur divisions were very satisfactory; prices maintained a high average and there was competition among the bidders.

The prices realised for red sanders in the Cuddapah and Chittoor divisions were below normal, due to want of demand in the Japanese market. This is only to be expected under present conditions.

(17) This Department participated in the All-India Khadi and Swadeshi exhibition in Salem and Calicut, and in the Madras Park Fair exhibition. The exhibitions attracted many visitors and enquiries were received for various forest products. Sandalwood, honey collected departmentally, and lac products were also sold in the exhibitions.

Mr. Scott, Joint Timber Advisory Officer to the Railway Board, New Delhi, visited the Madras Presidency and his note on revised specifications for sleepers is being considered by this Department. From the Forest Research Institute at Dehra Dun, Mr. Trotter, the Utilization Officer, Mr. Bhargava the Paper Pulp Expert, and Dr. Kapur, Officer in Charge of the Seasoning Section, all visited this Presidency, and discussions were held with them on various utilization problems relating to Madras.

Minor Forest Produce.

370 candies of *Nux vomica* seeds, collected departmentally in the Nellore division, were sold in auction at Rs. 8-4-0 per candy against Rs. 11-4-0 during the previous year.

Tans.—The question of extending the cultivation of *avaram* (*Cassia auriculata*) and the growing of wattle (*Acacia decurrens*) in suitable localities has been engaging the attention of the Department. The ruling

prices of local tan barks and the imported wattle bark in the Madras market are compared below :—

	—	Cassia auriculata,	Cassia fistula,	Wattle bark.
		Per ton. Rs.	Per ton. Rs.	Per ton. Rs.
April 1937	.	130	72	135
May 1937	.	114	67	125
June 1937	.	91	53	125
July 1937	.	103	54	125 to 130
August 1937	.	95	51	125
September 1937	.	90	53	125 to 130
October 1937	.	91	54	130 to 135
November 1937	.	90	54	127½ to 135
December 1937	.	99	59	130
January 1938	.	90	54	130 to 135
February 1938	.	91	54	128 to 130
March 1938	.	81	50	131

Aaram (Cassia auriculata) experimental plots.—The results obtained by the analysis of bark from two year old coppice shoots of *aaram*, grown in the experimental plots in Vizagapatam District, have not yet been received from the Leather Research Chemist to whom samples were sent in September 1937.

Analytical examination of *aaram (Cassia auriculata)* bark from trees of varying ages grown in our experimental plantations, one to five years in age, has shown that the quality of the bark depends on its tannin content, and not on its age. One year old bark from vigorous shoots has been found to be richer in tannin than 2 or 3 year old bark from thin wiry shoots. As a rule, bark from shoots of pencil thickness, irrespective of their age, is good for tanning purposes. Such one year old bark contains 16 per cent. to 20 per cent. tannin, and the rise in the tannin content of *aaram* bark from the first year to the third year, is between 2 and 3 per cent. only.

Results of analyses of *Konnai* bark (*Cassia fistula*) from coppice shoots one to six years old, from Rajahmundry, showed that bark from coppice shoots 4 to 5 years old contained the maximum quantity of tannin. In the tanners' opinion, very thin bark was useless for tanning purposes, as also very thick bark from old trees.

Terminalia arjuna.—In connection with the study of local tan stuffs, the Leather Research Chemist, Leather Trades Institute, Madras, was supplied with samples of *Terminalia arjuna* bark and fruits. The results of the analyses received are as below :—

	Bark.	Fruits.
Tans	15.84	8.16
Non tans	8.10	5.76
Insolubles	68.51	10.81
Moisture	7.49	75.27

Miscellaneous.

Beedi leaves.—Leaves of *Diospyros melanoxylon* are largely used in making ‘beedies’—the Indian substitute for cigarettes. The process of drying and curing the *beedi* leaves after their collection was examined, and the information gathered from the more important centres of collection was sent to the Conservator of Forests, Ceylon, on his request.

Katira or karaya gum.—This is the gum obtained from *Sterculia urens*. Inquiries for supply of this gum were received from Messrs. Ispahani and Sons, Madras, and from another firm in Cocanada. Various samples of the gum collected in Upper Godavari division were supplied to Messrs. Ispahani and Sons, Madras, who preferred the white variety. This firm and the other in Cocanada were put in touch with the District Forest Officer.

Walking sticks.—*Paciloneuron indicum* saplings are used in the manufacture of walking sticks in Mangalore. Both finished and raw sticks exhibited in the Calicut Exhibition were quickly sold out. This brought in a trial order from Mr. Edwards in Coimbatore, who was specialising in the manufacture of walking sticks from canes, bamboos and wood.

Lac.—Cultivation of lac in the Cumbum range, Madura division was continued. The yield was sold locally as scraped lac at Rs. 14 per manund of 82 lbs. and washed lac at Rs. 20 per manund ex-depot. 2,735 lbs. of scraped lac and 3,854 lbs. of seed lac sold during the year brought in a revenue of Rs. 1,696. The price of lac in the Calcutta market dropped during the year and this adversely affected our prices also which had to be reduced proportionately.

Lac produced in the Salem North division was used as usual in the manufacture of shellac, polish, varnish and other lac products. During the year, about 255½ gallons of lac polish were supplied to the Jails, 110 gallons to Messrs. Spencer & Co., Madras, and about 54 gallons to the P. W. D. and Industrial Schools, yielding a revenue of Rs. 1,751-4-9. Sales of lac products from the Departmental stalls in the exhibitions at Salem, Calicut and Madras Park Fair amounted to Rs. 572-15-6. Further samples of lac polish have been sent to the P. W. D., and it is hoped that orders will be forthcoming on a larger scale.

Her Excellency Lady Marjorie Erskine visited the Forest Department stall in the Park Fair Exhibition in December 1937, and was interested in the colourless lac polish prepared by the Department. Samples of colourless lac polish were sent to Government House, Madras.

The Kerala Soap Institute, Calicut, was supplied with several kinds of oil seeds, with a view to finding out their respective properties as a soap medium. The results of the experiments are awaited.

Attempts are being made to supply the Biochemist, Forest Research Institute, Dehra Dun, with *Lauraceae* seed fats containing lauric acid, which are reported to be coming into prominence.

An enquiry was received from a firm in Bombay for the supply of barks of *Holigarna arnottiana* with a view to carrying out some experiments with the juice obtained from it. The juice of the plant is very poisonous and affects the skin of human beings.

Increased sales of some important Minor Forest Products, particularly honey and bees' wax are assured, some of the important Medical Institutions, both private and Government, have placed their annual indents with this Department for supplies of these products. The demand has on several occasions exceeded the supply, and the Utilization division is endeavouring to pool the resources of all the Forest divisions, to meet this increased demand.

NORTH-WEST FRONTIER PROVINCE.

Wood working.—Sample sissoo logs (*Dalbergia sissoo*) cut from the Lower Swat canal banks, the management of which is now with the Forest Department, were sent to the Forest Research Institute for testing for veneers. It was found to be admirable as a decorative plywood, and offered no conversion or other difficulties. Examples of plywood made from this consignment were shown at the Forestry Section of the Lahore Exhibition.

ORISSA.

I.—GENERAL WORK AND ADMINISTRATION.

Owing to limited staff practically no work was possible.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

The Jhankorbahali lac orchard in Sambalpur division has been practically closed down. The *kusum* (*Schleichera trijuga*) brood has died out. There remain 28 *palas* (*Butca frondosa*) trees which are bearing some lac. Orders were issued to the District Forest Officer, Parlakimedi division, to experiment with *kusum* lac cultivation.

In Barapahar division a sum of Rs. 400 was spent in blasting operations in the Mahanadi river. Floating of bamboos is now a practical commercial possibility ; and further improvements to the river bed may be left to private enterprise to undertake. In the same division successful experiments in floating were undertaken in minor rivers such as the Danta and Jira.

In Ganjam division an experiment was made during the year, departmentally, of floating 5,000 bamboos and 3 dugouts from Bontha range down the Bodonodi and Rushikulya River to Ganjam. The experiment was not successful. It was found that, except for periodical spates, even during the rains the rivers are too shallow and sluggish for floating. When spates do occur they are so sudden and of such short duration that the produce is only carried a short distance before becoming stranded again. Any steady flow in the rivers is diverted by anicuts into the reservoirs. The produce actually reached Ganjam but the cost had been too heavy to give a profit on sales.

The Divisional Forest Officer, Angul division, supplied samples of timbers to the Orissa Engineering School, Cuttack, a furniture Company in Cuttack, toy making businesses in Cuttack and the Salvation Army, Angul. No laurel wood was despatched to the High Commissioner for India, but at the close of the year an order for 750 c. ft., was received. Matchwoods from this division continued to be supplied to the Talcher Match Works.

Mr. H. Trotter, Forest Utilization Officer at the Forest Research Institute, Dehra Dun, visited Cuttack in January 1938 and gave advice on the erection of a seasoning kiln and other projects for development. Dr. S. N. Kapur, later in the year, paid a visit to Cuttack to give technical advice to the private firm interested in the erection of a seasoning kiln. This firm is now awaiting a decision on the site for the new Capital of Orissa before committing itself to the project. In the meantime, in Puri division, 100 teak logs have been collected from wind-fallen trees and stacked in a seasoning shed for supply to the seasoning kiln when erected.

The Public Works Department purchased an Ascu treatment plant for use on the new Koraput-Rhayagada road. Towards the close of the year Government issued orders that all Government Departments and institutes should give preference to local timbers in all works for which timber is required. This order should stimulate consumption of local timbers. It has to be regretted that although timber was offered to the Public Works Department on favourable terms for the construction of Ascu treated wooden culverts and bridges on the Rairakhol, section of the Cuttack-Sambalpur road, it was decided to put up masonry

or ferro-concrete structures. This decision will involve importing raw materials instead of utilising the products of the Province.

The terms of the proposed bamboo leases in Barapahar and Sambalpur divisions to the Orient Paper Mill Company were settled after discussions with representatives of the Company. In exchange for an undertaking by the Company to employ a percentage of Oriyas in their Mills, Government has agreed to give concessions in respect of the royalty payable. These concessions may amount in the course of the next few years to about 2 lakhs of rupees.

During the year Government gave instructions to investigate the possibilities of growing fruit trees such as oranges, lemons, and jack within forest areas. Few suitable sites within reserves have been found available, and these are almost all in localities supporting good forest. In view of the great risk of damage from the depredations of wild animals, and the difficulty of marketing fruit grown in forest reserves, the writer believes that large scale attempts to establish orchards within other than very open forest reserves are bound to prove a costly failure, and that, instead, efforts should be concentrated on encouraging villagers to grow fruit trees in waste lands and unreserves.

The Forest Department was also asked to investigate the possibility of irrigation schemes. The Labangi irrigation channel which was constructed in 1935 with funds supplied by the Civil Department was widened and improved. Some 10 acres of *toila* land were irrigated, and paddy grown thereon. A more extensive use is expected to be made in 1938-39.

UNITED PROVINCES.

I.—GENERAL WORK OF ADMINISTRATION.

After remaining in abeyance for six years the post of Forest Utilisation Officer was revived as a divisional charge as an experimental measure for a period of one year from October, 1937. A recommendation has recently been sent to Government asking for the renewal of the post for a further period of three years.

Mr. D. Stewart, O.B.E., Deputy Conservator of Forests, held charge of the post from 3rd October, 1937. He has been constantly on tour throughout the six months under report, and has visited most forest divisions in the United Provinces, and nearly all the big towns in the United Provinces with important markets for, and industries connected with, forest produce. He also paid two visits to the Forest Research Institute, Dehra Dun, and attended the Sleeper Pool Committee meeting at Delhi in November, 1937.

II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

(1) *Wood technology.*

2. Sections of the stem of *Sterculia urens* were sent to the Wood Technologist, Forest Research Institute, in connection with experiments which are being conducted in Jhansi forest division with a view to discovering the best method of tapping this tree for *karar* gum, the old methods having led to deterioration and heavy mortality of the trees. A report has been obtained and experiments are being continued on the lines indicated by the Wood Technologist.

(2) *Timber seasoning.*

3. (i) An experiment was started, in collaboration with the Forest Research Institute, with a view to following the career of a number of *Pinus longifolia* (chir) sleepers from the tree to the creosoting plant and later in the railway line. It is proposed to study the seasoning of the sleepers from the time they are cut right up to the time they are used, in order to get definite information on the amount and nature of their seasoning defects, and the rate of drying of the sleepers at various stages of seasoning, with a view to suggest ways and means of improving the seasoning of such sleepers, as well as of minimising seasoning degrade, which is alleged to be the cause of considerable rejection at the time of passing.

The Assistant Seasoning Officer, Forest Research Institute, visited the East Almora Forest division in October, 1937, to initiate the experiment and again paid a second visit to Tanakpur and East Almora division in February and March, 1938, in the same connection. A preliminary report on the subject was received from the Forest Research Institute in March, 1937, and the experiment is being continued.

4. (ii) A further experiment was started in collaboration with the Forest Research Institute and the Rohilkund and Kumaon Railway to collect information on the seasoning of M. G. *sal* sleepers obtained from the United Provinces forests and laid in line in a moderately dry locality. The following points are being investigated :—

- (a) The exact amount of seasoning which sleepers undergo in a year's stacking in close-crib manner, and the seasoning degrade which occurs during this period.
- (b) The effect of seasoning for a year on the life of a sleeper and whether there is any benefit in seasoning *sal* sleepers before laying them in the line.

Lucknow was selected as the site for the experiment. The sleepers were divided into two lots of 500 each, one lot being laid in the line

immediately and the other lot being kept stacked in close-crib manner for a year under the shade of trees, preparatory to being laid in the line in the same locality as the first lot. The behaviour of the sleepers will then be noted periodically and a complete record of the life of each sleeper kept in order to arrive at the average life of the two lots of sleepers for comparative purposes.

(3) *Timber testing.*

5. The following consignments of timber were sent to the Forest Research Institute for test under different projects.

(1) Thirty-five billets of *Anogeissus pendula* (*kardai*) from Jhansi division for test under Project No. O, to ascertain its suitability for tool handles, shuttles, etc. A preliminary test carried out at the Forest Research Institute with green specimens of this timber indicated that it is very much superior to ash and practically equal to hickory in strength qualities. As there are considerable supplies of the timber available in Jhansi division, the results of the final test at the Forest Research Institute are awaited with interest.

(2) Consignments of *sal* timber from several divisions in the United Provinces have been sent to the Forest Research Institute in connection with the all India Project to determine the relative strengths of *sal* from different localities. It has also been arranged that these consignments of *sal* from different localities in the United Provinces should also be subjected to durability tests.

(4) *Wood preservation.*

6. The only departmental work done was the Ascu treatment of some tramway sleepers for the Haldwani division tramway in the small Ascu treating plant installed in that division last year. Some fencing posts were also treated in the same plant. This was done on a comparatively small experimental scale, and both the sleepers and fencing posts are being kept under observation.

During the year the Forest Utilisation Officer inspected a considerable number of Ascu treated *sal* and *chir* electric transmission poles which have been erected in various parts of the United Provinces during the last few years. The *sal* poles, which number approximately 10,000, were erected mostly by the United Provinces Hydro-Electric department between 1935 and 1937 principally on short distribution lines to tube wells. The only lot of *chir* poles is in the town of Fyzabad, the entire electric distribution system of which was done by Messrs. Callender's Cable and Construction Co., Ltd., in 1937, with Ascu treated *chir* poles.

During the year about 1,000 *chir* poles for electric distribution lines were supplied to Messrs. Callender's Cable and Construction Co., Ltd. These are being *Aseu* treated in the firm's plant at Bareilly.

7. It is too early yet to make any useful remarks about the behaviour of the *Aseu* treated poles hitherto erected in the United Provinces, but the necessity for maintaining adequate records and statistics with a view to watching the behaviour and ascertaining the effective life of these poles in the line is obvious. Such records and statistics for treated poles are maintained on a large scale in Europe and America, and the Forest Utilisation Officer is at present working out a scheme for maintaining similar records in the United Provinces in collaboration with the Forest Research Institute and the firms and Government departments which have installed the poles.

8. Owing to the present high price of steel poles the Forest Utilisation Officer has recently received numerous enquiries from Electric Supply Companies and others throughout the province about the possibility of supplying suitable wooden poles. This matter is now being actively taken up and a note has been issued to about forty different companies and electrical engineers detailing the arrangements which the United Provinces Forest department is prepared to make. Briefly the proposed system is that the department will arrange with forest contractors who purchase forest lots by auction to enter into voluntary agreements with Electric Supply Companies, etc., to deliver untreated poles up to specification at a price to be fixed before the auctions. Passing of the poles will be done at railway stations by Forest department passing officers and payment made by the companies direct to forest contractors after the poles are passed. The arrangements and method of preservative treatment are being left to the Electric Supply Companies concerned. No treatment will be done departmentally. The poles which are being recommended for use are fairly large size *sal* poles which are naturally straighter than small *sal* poles and can be obtained in larger numbers up to specification. Part of the sap wood can be trimmed from such poles in order to give greater straightness, and the cost of preservative treatment is reduced as the poles contain a fairly large amount of heart-wood which does not absorb preservative, and also does not require it.

(b) Minor forest products.

9. (i) *Karar gum* from *Sterculia urens*.—Departmental work in collecting this gum was undertaken in the Jhansi forest division and various methods of tapping adopted experimentally with a view to arriving at the best results. Departmental work was resorted to on account of the serious damage done to the trees by the destructive methods of tapping previously employed by contractors. The gum

collected departmentally was graded and good prices were obtained by auction in December 1937, which seems to show that it pays to grade the gum. Prices obtained at more recent auctions have been somewhat lower, apparently due to the fairly large amount of gum on the market.

(ii) *Lac*.—Prices for lac continued to be very low and a large number of the small shellac factories in Mirzapur have closed down as the present price of shellac makes production unprofitable.

(6) *Paper pulp*.

10. (i) *Experimental*.—A consignment of about twenty tons of *ulla* grass (*Anthoxanthia gigantea*) was sent to the Upper India Couper Paper Mill Ltd., Lucknow, to test its suitability for making high class writing and printing paper on a commercial scale. The result of the test is still awaited. Previous tests with this grass at the Forest Research Institute on a semi-commercial scale were promising but inconclusive. It is estimated that about 48,000 tons per annum of this grass will be available at an economic price from the United Provinces forests.

Arrangements were recently made to send one and a half tons of *ulla* grass to the Forest Research Institute to test its suitability for making kraft paper, cheap wrapping paper and wall boards. At least one commercial concern in the United Provinces is interested in starting an industry to manufacture one or more of these products.

The experiments with regard to utilising *chir* pine billets for the manufacture of pulp suitable for kraft and cheap wrapping papers which are proceeding at the Forest Research Institute are also of considerable interest to the United Provinces as also the possibility of using *chir* pine billets and refuse for the manufacture of wall boards. At least one commercial concern is interested.

11. (ii) *Commercial*.—During the year the construction of a new paper mill, the Star Paper Mills Ltd., was started at Saharanpur and it is anticipated that the mill will start work very soon. This mill will be dependent on the *baib* grass supplies of the Western Circle, United Provinces, and has been granted by Government a long lease of these supplies for the manufacture of paper.

All the remaining *baib* grass supplies from the United Provinces forests are being utilised by the Upper India Couper Paper Mill Co., Ltd., Lucknow, the Shree Gopal Paper Mill, Jagadhri, and the Rohtas Industries Ltd. Paper Mill, Dohri-on-Sone.

The demand for *baib* grass supplies from the United Provinces forests is now very intense, both from paper mills and the cottage rope making industry. The question of artificial propagation of this grass on a fairly large scale, both inside and outside the forest areas, is under considera-

tion and is likely to be a very profitable proposition, both for supply to paper mills, the demand from which considerably exceeds the supply, and for the expansion of the existing rope making industry.

(7) *Tans.*

12. Nothing to record.

(8) *Wood working.*

13. There are no wood-working concerns in the United Provinces under the control of the Forest department but the Forest Utilisation Officer maintained touch with the two wood working institutes under the control of the Industries department at Bareilly and Allahabad and with all the principal commercial wood working concerns and the furniture making trade, with a view to assisting them in obtaining their requirements of timber at fair prices. The main difficulty is in arranging for adequate supplies of suitable timbers to the Bobbin Factory of the Indian Turpentine and Rosin Co., Ltd., at Clutterbuckganj both as regards quantities required and at prices which can allow Indian made bobbins to compete successfully against imported Japanese bobbins. The timber which makes the best bobbins is *Adina cordifolia* (*haldū*) but this timber has a higher value in the ordinary market than the bobbin industry can afford to pay. Available supplies are also inadequate for the bobbin industry in addition to the ordinary market. Another good timber for bobbins is *Hymenodictyon excelsum* (*baurang*) but the quantities available are very small. Efforts are being made to overcome these difficulties with a view to keeping the industry alive.

14. The sawmill of the Indian Turpentine & Rosin Co., Ltd., uses about one lakh cubic feet of *Bombax malabaricum* (*semal*) per annum for making packing cases, in addition to sawing up the various timbers required for bobbins, etc. Other two smaller privately owned sawmills at Lalkua and Haldwani utilise nearly a lakh of cubic feet of *semal* for packing cases.

The furniture trade, principally at Bareilly, uses considerable quantities of *Dalbergia sissoo* (*sissu*).

The Gun Carriage Factory at Jubbulpore takes considerable quantities of *sal*, *sissu* and *Holoptelia integrifolia* (*kanju*) from the United Provinces forests, and the Forest Utilisation Officer kept in close touch with the factory and with the Joint Timber Advisory Officer, Railway and Defence departments, about these supplies.

(9) *Miscellaneous.*

15. (i) *The Match Industry.*—There is a very heavy demand for *Bombax malabaricum* (*semal*) for splints and boxes from match

factories in the province, in fact the demand is now so great that it cannot be met in full in addition to supplying the demands of various sawmills which require *semal* for the manufacture of packing cases. The largest consumer of *semal* is the Western India Match Co. factory at Bareilly, but there are several other small Match factories at Bareilly, Cawnpore, Lucknow and Haldwani. The last two mentioned were opened during the year, and several enquiries were received regarding the possible supply of timber to other proposed new factories. In all cases, replies had to be sent discouraging these proposals, as supplies of suitable timbers do not exist in the province. The question of what steps are to be taken to ensure adequate future supplies of match timbers by making plantations on a considerable scale is now receiving the serious attention of the Forest department. There is at present a market in the province for about five to six lakhs cubic feet of *semal* timber per annum for matches and packing cases whereas the available supply does not exceed three and a half lakhs cubic feet per annum.

16. (ii) *Plywood and Veneers*.—During the year a Cawnpore firm proposed a scheme for the manufacture of commercial plywood plus decorative veneers and laminated boards, requiring about 400,000 c. ft. of *semal* and other timbers suitable for making cheap commercial plywood. The scheme was thoroughly investigated and ultimately had to be definitely discouraged so far as cheap commercial plywood is concerned, as the supplies could not be made available without cutting off existing supplies to match factories. So far as decorative veneers and laminated boards are concerned supplies of suitable timbers are ample but the firm considered that the manufacture of these without the addition of commercial plywood would not be a sufficiently attractive proposition financially. Other wood working concerns who already possess saw milling machinery are, however, being encouraged to take up the manufacture of decorative veneers and laminated boards. Some of them are definitely interested in the proposition and it is hoped that this industry will soon be started in the provinces.

Meanwhile the question of what steps should be taken to grow timbers on a large scale suitable for the manufacture of commercial plywood is engaging the serious attention of the department.

17. (iii) *Sleeper supplies to Indian Railways*.—The Indian Railways are the biggest individual customers of the United Provinces Forest department. For many years past the Tarai Group Sleeper Pool has bought about two and a half lakhs of metre gauge *sal* sleepers annually from the United Provinces forests. The system of supply, passing, and payment is on a semi-departmental basis, which has worked smoothly and to the mutual benefit of the Group and the Forest department. All passing of sleepers for the Group is done by the Forest depart-

ment passing officers and one of the duties of the Forest Utilisation Officer is to standardise sleeper passing throughout the province, and to maintain liaison with the Group on all matters affecting this sleeper supply. Relations with the Group continue to be most cordial.

During the year under report an arrangement similar to the Tarai Group arrangement was brought into force with the Northern Group Sleeper Pool for the supply of about 32,500 c. ft. bridge and crossing sleepers to the North Western Railway valued at about Rs. 72,400. The arrangement is working satisfactorily and it is hoped it will continue. Passing of sleepers is done by Northern Group passing officers.

The old three year contract for the supply of *chir* broad gauge sleepers to the North Western Railway through the Northern Group Sleeper Pool is under renewal for a further period of three years. The new contract is for an annual supply of 130,000 broad gauge sleepers at Rs. 3-2 per sleeper f.o.r. forest railway stations. These sleepers are creosoted at the North Western Railway treating plant at Dhillian. Creosoted *chir* sleepers continue to give excellent service in the track.

18. (iv) *Railway freight rates*.—This matter has an important bearing on the United Provinces timber markets and prices, as the United Provinces forests are tapped by several railways, private and state owned, the freight rates on which differ considerably. The Forest Utilisation Officer is making a study of special cases in which reduction of freight rates would help markets, particularly for fuel, in certain towns in the United Provinces, and it is hoped that it will be possible to convince the railways concerned of the necessity for special rates in certain cases.

19. (v) *Enquiries and liaison*.—Numerous enquiries were answered regarding the availability and sources of supply of various timbers and other forest produce. Liaison was maintained with the Forest Research Institute, the Joint Timber Advisory Officer, Railway and Defense departments, Delhi, the Director of Industries, United Provinces, and all the wood working industries in the province.

20. (vi) *Minor Industries dependent on forest products*.—At the request of the United Provinces Government a survey was made during the year regarding steps which can be taken to foster and increase minor and village industries dependent on supplies of forest products and a report is in course of preparation.

APPENDIX I.

List of Provincial Forest Publications of 1937-38 (excluding the Forest Research Institute Publications).

ASSAM.

Flora of Assam, Assam Forest Record, Vol. II (Botany).

Indian Forester—

Hollock regeneration, by J. N. Das.

Aided natural regeneration of sal established, by R. N. De.

Grazing and its effect on simul regeneration, by J. B. Rowntree.

BENGAL.

Nursery and Plantation Notes for Bengal, 4th edition, by C. K. Homfray, 1937.

Graphs giving Volume/Ago for the more important species found in the Northern and Southern Bengal, compiled in the office of the Silviculturist, Bengal; (Bengal Forest Bulletin No. 2).

List of Scientific Plots maintained by the Silvicultural Division, Bengal; (Bengal Forest Bulletin No. 3).

Indian Forester—

History of the Management of the Darjeeling Forests, by E. A. C. Moddar.

Kamrup method of natural regeneration of sal and the possibility of its application to Bengal, by R. I. Macalpine.

Note on the Ilacca-Mymensingh Forest Division, by Y. S. Ahmad.

BIHAR.

Bihar Grading Rules for timbers.

Floating a cheap means of transport.

Contour trenching at Bamaburu.

Flood Problem in Bihar—need to enforce control measure.

A brief account of Bihar Timber.

A note on the seasoning of Indian Timbers.

Indian Forester—

The irrigation of dry hill sal areas.

State control over private forests in Finland, by J. N. Sinha.

BOMBAY.

Indian Forester—

Note on *Casuarina equisetifolia* plantation in Karwar, by D. S. Kaikini.

Description of the Government Depot at Kodibag, by D. S. Kaikini.

The Future of Forests, by E. A. Garland.

Forests and Man, by E. A. Garland.

CENTRAL PROVINCES.

Indian Forester—

Departmental collection of kulu gum (*Sterculia urens*) in Damoh division, by Kesar Singh.

Regeneration of frost-labile forests in the Central Provinces, by K. P. Sagreya.

Departmental exploitation of forests in Nimar division, by S. A. Vahid.

MADRAS.

Indian Forester—

Regeneration and propagation of sandalwood, by S. Rangeswami.
 Silvicultural experiments, by J. Banerji.
 Secondary sources of moisture for the soil, by M. V. Laurio.

ORISSA.

Indian Forester—

Results of coppicing, pollarding and pruning experiments to stimulate *Strychnos nux vomica* fruit production, by J. W. Nicholson.

PUNJAB.

The depth and frequency of irrigation in plantations, by R. S. Chopra (*Punjab Forest Records*, Vol. 1, No. 4).
 Propagation of *Karer*, by R. S. Chopra (*Punjab Forestry Notes*, No. 2).
Phulai (*Acacia modesta*, Willd.), by R. S. Chopra (*Punjab Forestry Notes*, No. 3).
Hazar cultivation in the Punjab, by R. S. Chopra (*Punjab Forestry Notes*, No. 4).
 Soil losses, by R. M. Gorrie.
 Advantages of Irrigated Plantations, by R. M. Gorrie.
 Soil erosion, by R. M. Gorrie.
 Afforestation of villages in the Punjab, by R. M. Gorrie.
 Punjab Forest Resources, by R. M. Gorrie and I. D. Mahendru.
 Forests in Punjab Rural Life, by R. S. Chopra.
 Commercial guide to Punjab timbers, by I. D. Mahendru.
 Leaflet on air seasoning.
 Soil erosion : an outline for practical teaching in schools, by R. M. Gorrie.

Indian Forester—

Erosion survey of the Uhl valley, by R. M. Gorrie.
 Reclamation in the Pabbi Hills, by R. M. Gorrie.
 Thinning practice in coniferous forests, by N. G. Pring.
 Protection of *Prosopis juliflora* pods from attack by *Caryoborus gonagra*, by C. L. Kapur.
 Results of silvicultural treatment of Bamboos in the Hoshiarpur division, by I. D. Mahendru.
 Single tree silviculture in Indian conifers, by R. M. Gorrie.
 A note on *Ulmus villosa* Brandis and on other elms in the N. W. Himalaya, by R. N. Parker.
 The measurement of soil erosion and run-off, by R. M. Gorrie.
 The Balsan State Forests, by N. G. Pring.
 Two years old bamboo seedling, by Saeed Ahmad.
 Collett's Flora Simlaensis, by R. N. Parker.
 Crown ratio in Indian Conifers, by R. M. Gorrie.
 Stone bunds in erosion control, by R. M. Gorrie.

UNITED PROVINCES.

Forest Pocket Book, 4th edition, by S. H. Howard.

Tanngyas of the Saharanpur Forest division, by M. D. Chaturvedi, U. P. Forest Department Bulletin No. 10.

Indian Forester—

The Shelterwood coppice system, by W. T. Hall.
 Large sal tree, by N. N. Sen.
 Some notes on the Kamrup method of sal regeneration, by H. G. Chapman.
 A note on the bridge over the Ramganga at Kalagarh, by R. N. Brahmawar.

APPENDIX II.

Statement showing rank, designation and address of Forest officers employed exclusively on research work in the various Provinces during 1937-38.

Serial No.	Name.	Designation.	Address.
1	Dr. N. L. Bor, Deputy Conservator of Forests.	Held the combined post of Botanical Officer and Silviculturist, Assam, from 1st April 1937 to 10th October 1937.	Shillong.
2	Mr. R. N. De, Deputy Conservator of Forests.	Held the combined post of Botanical Officer and Silviculturist, Assam, from 11th October 1937 to 31st March 1938.	Do.
3	Mr. S. M. Dob, E. A. C. of Forests.	Forest Utilisation Officer, Assam.	Gauhati.
4	Mr. J. C. Nath, Deputy Conservator of Forests.	Silviculturist, Bengal . . .	Darjeeling.
5	Mr. S. C. Chatterjee, E. A. C. of Forests.	Assistant Silviculturist, Bengal, (1st April 1937 to 30th June 1937 and 1st December 1937 to 31st March 1938).	Do.
6	Mr. S. K. Datta, E. A. C. of Forests.	Assistant Silviculturist, Bengal (1st July 1937 to 30th November 1937).	Do.
7	Mr. C. T. Trigg, Deputy Conservator of Forests.	Forest Utilisation Officer, Bengal (1st April 1937 to 24th November 1937).	Calcutta.
8	Mr. S. Chaudhuri, Deputy Conservator of Forests.	Forest Utilisation Officer, Bengal (25th November 1937 to 31st March 1938).	Do.
9	Mr. W. D. M. Warren, Deputy Conservator of Forests.	Forest Research Officer, Bihar	Ranchi.
10	Mr. K. P. Sagreya, Deputy Conservator of Forests.	Silviculturist, C. P. . .	Nagpur.
11	Khan Sahib Abdus Salam, E. A. C. of Forests.	Forest Utilisation Officer, C. P.	Do.
12	Mr. A. L. Griffith, Deputy Conservator of Forests.	Silviculturist, Madras . . .	Ootacamund.
13	Mr. M. Srinivasa Raghvan, E. A. C. of Forests.	Assistant Silviculturist, Madras	Do.
14	Mr. Mohd. Abdul Hafiz Sabib	Forest Utilisation Officer, Madras.	Madras.

APPENDIX II—*contd.*

Serial No.	Name.	Designation.	Address.
15	Mr. J. W. Nicholson, Conservator of Forests.	Carried out the duties of Research Officer in addition to his own duties.	Angul.
16	Dr. R. M. Gorrie, Deputy Conservator of Forests.	Divisional Forest Officer, Silvicultural Research Division, Punjab (1st April 1937 to 31st January 1938).	Lahore.
17	Mr. I. D. Mahendru, E. A. C. of Forests.	Divisional Forest Officer, Silvicultural Research Division, Punjab (1st February 1938 to 31st March 1938).	Do.
18	Mr. I. D. Mahendru, E. A. C. of Forests.	Attached Officer, Silvicultural Research Division, Punjab (1st April 1937 to 31st January 1938).	Do.
19	Mr. R. S. Chopra . .	Attached Officer, Silvicultural Research Division, Punjab.	Do.
20	Mr. F. C. Ford-Robertson, Deputy Conservator of Forests.	Silviculturist, U. P. (1st April 1937 to 9th May 1937).	Naini Tal.
21	Mr. E. C. Hobbs, Deputy Conservator of Forests.	Silviculturist, U. P. (10th May 1937 to 31st March 1938).	Do.
22	Mr. M. A. Kakarai, E. A. C. of Forests.	Assistant Silviculturist, U. P. (1st March 1937 to 12th February 1938).	Do.
23	Mr. D. Stewart, Deputy Conservator of Forests.	Forest Utilisation Officer, U. P. (from 3rd October 1937 to 31st March 1938).	Bareilly.

APPENDIX III.

*Publications of the Forest Research Institute, Dehra Dun,
available for Sale.*

SILVICULTURE SERIES.

BULLETINS (Old Series).

	PRICE. Rs. A. P.
*4. <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0

PAMPHLETS.

*6. Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger	1 0 0
*8. Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Cacein	0 10 0
*9. Tables showing the Progress in Working Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author	0 10 0
*16. Note on the Best Season for Coppice Fellings of Teak (<i>Tectona grandis</i>), by R. S. Hole	0 4 0

BULLETINS.

2. Memorandum on Teak Plantations in Burma, by F. A. Leote	0 10 0
*8. Note on some Germination Tests with Sal Seed (<i>Shorea robusta</i>), by R. S. Troup	0 2 0
*22. Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0 5 0
*30. The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
*33. Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill	1 0 0
*41. Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion	0 8 0
*45. Note on the Miscellaneous Forests of the Kumaon Bhawar, by E. A. Smythies	1 0 0
*46. Rate of Growth of Bengal Sal (<i>Shorea robusta</i>), I Quality, by S. H. Howard	1 0 0
*47. Volume Tables and Form Factors for Sal (<i>Shorea robusta</i>), by the same author	0 6 0
*58. General Volume Tables for Chir (<i>Pinus longifolia</i>), by S. H. Howard	0 8 0
*62. Preliminary Yield Table for <i>Dalbergia sissoo</i> , by S. H. Howard	0 2 0
*65. Tables for bark deductions from logs, by S. H. Howard	0 3 0
*67. Chir (<i>Pinus longifolia</i>) Seed Supply, by S. H. Howard	0 3 0
*78. The Problem of the Pure Teak Plantation, by H. G. Champion	0 12 0
*82. The Measurement of Standing Sample Trees, by H. G. Champion	1 2 0
*83. Provisional Yield Table for <i>Quercus incana</i> (Banj or Ban-oak), by H. G. Champion and I. D. Mahendru	0 14 0
*86. Cold Weather Planting in Northern India, by H. G. Champion	0 9 0
*87. Yield Tables for Teak Plantations in Java, by H. G. Champion	0 14 0
*88. Seasonal Progress of Height Growth in Trees, by H. G. Champion	0 14 0
*89. Effect of Defoliation on the increment of Teak Saplings, by H. G. Champion	0 3 0
*91. Damage by Frost at New Forest, Dehra Dun, during 1930 to 1934, by Bachaspali Nautival	0 12 0

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*Vol.	VI, Part	II.—Statistics compiled in the Office of the Silviculturist, Forest Research Institute, Dehra Dun, during 1915-16	1 6 0
*	“ Part	V.—Statistics compiled in the Office of the Silviculturist, Forest Research Institute, Dehra Dun, during 1916-17	0 10 0
*Vol.	VIII, Part	II.—The Regeneration of Sal (<i>Shorea robusta</i>) Forests, by R. S. Hob	2 2 0
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MEMOIRS.

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†Practical Determination of the Girth Increment of Trees, by R. S. Troup	0 4 0
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†Note on the Forests of Java and Madorea, by the same author	0 13 0
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*Silvicultural Research Manual for use in India, Vol. I.—(Experimental Manual), by H. G. Champion	2 0 0
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(PUBLICATIONS—PRINTED OUTSIDE INDIA.)

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† " " Vol. II, 4th edition, 1910	7 7 0
† " " Vol. III, 5th edition, 1925	14 1 0
†Silviculture of Indian Trees, by R. S. Troup, 3 Vols., for forest officers	40 0 0
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" "	Part V.	Note on <i>Trametes pini</i> , by the same author	1 0 0
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*Vol.	XIII, Part I.	Illustrations of Indian Forest Plants—Part I— Five Species of <i>Dipterocarpus</i> , by R. N. Parker	1 0 0
*Vol.	XVI, Part I.	Illustrations of Indian Forest Plants—Part II— Five Species of <i>Dipterocarpus</i> , by R. N. Parker	1 0 0
*Vol.	XX, Part XV.	Illustrations of Indian Forest Plants, Part III, by R. N. Parker and C. E. Parkinson	0 14 0

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